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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Registered Office and Laboratories of the B.C.I.R.A. are at:—
24, ST. PAUL'S SQUARE, BIRMINGHAM.
Telephone: Central 1885. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone* 332).

Forthcoming Events.

SEPTEMBER 6-12.
International Association for Testing Materials:—First International Congress at Zürich.

SEPTEMBER 10-26.
Shipping, Engineering and Machinery Exhibition:—To be held at Olympia, London.

SEPTEMBER 12-27.
International Foundry Congress and Exhibition, at Milan.

SEPTEMBER 13-18.
Institute of Metals:—Autumn meeting at Zürich.

SEPTEMBER 23-30.
British Association:—Centenary meeting in London.

SEPTEMBER 29-OCTOBER 2.
Iron and Steel Institute:—Autumn meeting at Swansea.

American and German Research.

The Paper reproduced in our last issue by Mr. Speller on "Co-operative Research in the Iron and Steel Industry" gave the present position of the research activities of American and German industry, and it is one which should cause many people in this country to think hard. It cannot be denied that research was taken up in the countries which came into the industrial field later than did Britain, partly as a means of neutralising the superior advantage we enjoyed on account of our early start, our geographical situation and natural resources. The tremendous advantage we once enjoyed as a consequence of our compactness has largely disappeared, on account of the development of the automobile and aeroplane. These have reduced the handicap of long distances in countries whose producing centres are far apart and distant from the consumer.

The first important point is the very wide definition given to the term "research," which is practically taken to include everything likely to have any bearing on the development and progress of the industry, even if not, in the strict sense of the term, scientific. The charts of the great German steelworks research departments show two departments, closely related, having as their respective functions what is called in this country research and development; that is, scientific investigation and its application to the industry. They also show the remarkable extent to which co-operative research is carried on in both countries virtually without the stimulus of Government aid.

A second important point is the extent to which research is supported financially. According to this Paper, the chemical industry in the States spends an amount annually exceeding 2 per cent. of its capital; which in these times is almost equivalent to a dividend. On the other hand, the American steel industry only spends 0.04 per cent. It is very difficult to ascertain what the capital of the British founding industry is, and probably the figure of invested capital has little relation to present-day values and is complicated by items for good-will, etc. It has been estimated that the value of the products of the industry in a reasonably normal year is £40 million. Assuming that the capital employed is only double this figure (probably a conservative estimate), the industry would have to spend £40,000 per annum on research in order to reach the very moderate figure of a twentieth of 1 per cent. of its capital. In actual fact it does not reach anything like this figure. Under modern conditions, the tendency is to estimate the capital of a company in terms of its earning power, and nothing is likely to stimulate this so much as a carefully-directed research policy.

Profit and Loss.

An American firm of foundry engineers has published an advertisement in which are given nine pointers for where profits can be made, and a like number for losses. Yet we remain unconvinced that the crucial points have been included. The obvious point, to our mind, is the relationship of overheads to the volume and price obtained for the finished castings. In fact, any foundry should know the minimum amount of work at an average selling price which will cover the overhead charge, which is more or less a constant. The bull points in the American advertisement are (1) modern yard facilities; (2) mechanical charging of furnaces; (3) monorail distribution of metal; (4) machine moulding; (5) vertical core ovens; (6) adequate cleaning apparatus; (7) mould conveyors; (8) straight-line production methods, and (9) well-lighted, ventilated and heated shops specially constructed for the job. These are certainly excellent premises, and all one has to do to make for completion is to add, as number 10, automatic sand preparation and distribution. Yet one feels that all this is governed by an assurance of an adequate volume of orders to cover the enhanced overheads consequent upon such mechanisation, but second thoughts show that such work has to be undertaken sooner or later, as competition is so forcing the pace that the whole character of the foundry industry is being changed. These ten points, once considered to be only necessary for automobile and radiator foundries, have spread, and are now covering every phase of builders' and municipal and certain types of electrical castings. There are a number of underlying principles which are applicable to all foundries, such as: material has to be assembled and melted; sand has to be prepared and transported to moulds, and castings have to be cleaned and despatched. The methods of accomplishing these functions economically will vary according to the value of the land. For instance, the whole of the boxes at the Standard Brass Foundry Company at Benoni, South Africa, leave the foundry every night, and the whole stock is permanently carried on trucks running on rails in a large siding, provided with innumerable turntables. If the value of the ground is low, no better system could possibly be devised for a jobbing shop, but in the centre of Birmingham, Manchester or Sheffield, we feel reasonably certain that the cost of local rates would birth-strangle any such proposition. Nevertheless, it is the solution of this and kindred problems that must now engage the attention of the industry.

XUM

The British Cast Iron Research Association.

VII.—HOW THE ASSOCIATION IS GOVERNED—(*Concluded.*)

Other Committees.

One of the most interesting committees is the Scottish Committee, formed from Scottish members and responsible for the supervision of the Association's laboratory in Scotland, the Foundry Technical Institute, Falkirk. This committee is composed as follows:—

Mr. G. L. Anderson (Camelon Iron Company, Limited, Falkirk).

Mr. J. Arnott, A.I.C. (G. & J. Weir, Limited, Glasgow).

Mr. J. Cameron, J.P. (Cameron & Roberton, Limited, Glasgow).

Captain H. J. Kennard, R.N. (Falkirk Iron Company, Falkirk).

Mr. L. P. Mackenzie (Mackenzie & Moncur, Limited, Edinburgh).

Mr. G. Pate, O.B.E., J.P. (Carron Company, Falkirk).

Mr. J. M. Primrose (Grangemouth Iron Company, Falkirk).

Mr. D. M. Semple (Mirrlees Watson Company, Limited, Glasgow).

Mr. A. W. Steven, J.P. (McDowall, Steven & Company, Limited, Falkirk).

Mr. G. A. Ure, J.P. (Smith & Wellstood, Limited, Bonnybridge).

Mr. John Watson (Andrew Barclay, Sons & Company, Limited, Kilmarnock).

Mr. G. A. Ure is chairman of this committee and Mr. J. Cameron is vice-chairman. Other territorial committees would be formed if the demand existed, but the concentration of light-castings production in the Falkirk area provides special reason for the existence of the Scottish Committee.

Other Committees and Sub-Committees.

Other committees and sub-committees are formed as and when required, and dissolved when the immediate purpose of their formation is solved. The Research Committee, for instance, has two important sub-committees which meet only at infrequent intervals: the Patents Sub-Committee and the Scientific Sub-Committee. The former is charged with the duty of working out the Association's patent-policy, and to the latter the Association is indebted to a group of the most eminent metallurgists in the country for advice in the conduct and publication of scientific work. These two committees are constituted as follow:—

Patents Sub-Committee.

Mr. F. J. Cook, M.I.Mech.E.

Mr. W. T. Griffiths, M.Sc. (Mond Nickel Company, Limited, London).

Mr. W. B. Parker, F.I.C. (British Thomson-Houston Company, Limited, Rugby).

Prof. Emer. T. Turner, M.Sc.

Scientific Sub-Committee.

Prof. Sir Harold Carpenter, F.R.S. (Imperial College of Science and Technology, London).

Prof. C. H. Desch, D.Sc. (The University, Sheffield).

Prof. D. Hanson, D.Sc. (The University, Birmingham).

Dr. H. Moore, O.B.E. (Research Department, Woolwich Arsenal).

Dr. W. Rosenhain, F.R.S.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Cupola-Melted Copper.

To the Editor of The Foundry Trade Journal.

Sir,—In your issue of August 6 there appeared an article by T. Mauland on melting non-ferrous alloys in an open cupola. This interested me very much, as I have seen a quantity of copper melted in this way, but an event occurred which I never have understood: that is, that when the copper was poured into the moulds, it started to vomit out again after about 10 or 20 sec., and the casting, when dressed and machined, showed a considerable number of small holes right through it, like a honeycomb. Can you tell me the reason and cure for this, as it would seem to be a very costly matter to the founders? As far as I could see, the copper used was a mixture of firebox plate and scrap copper castings.—Yours, etc.,

G. Chambers.

24, Beech Grove, Seaforth, Lancs.
August 28, 1931.

[It is difficult to say without much more evidence the cause of the blow-holes. If they were merely subcutaneous, we would suspect too high a casting temperature.—Editor.]

Notes from I.B.F. Branches.

Lancashire Branch, Junior Section.—There will be a works visit to the Barton Power Station of the Manchester Corporation Electricity Department on Saturday afternoon, September 5. Members participating in this visit should arrive at the works at not later than 2.45 p.m.

A New High-Temperature Refractory Cement.

A silicon-carbide refractory cement, for which a fusion point of over 1,650 deg. C. and a minimum of shrinkage are claimed, is now being marketed in America under the trade name of "Heat Resisto," states the "Iron Age." The uses of this cement include the laying-up of brickwork in cupolas, brass furnaces, boilers, annealing and other heat-treating ovens. The material is diluted with water to make a thick cream, and the bricks are then dipped in it and tamped close, making thin joints. The face of the brickwork may be coated with the same material to protect the brick from the action of flames and slag.

The cement may also be used for monolithic linings, ladle and stove linings and for general repairs, including the covering of slag-covered, burned-out firebrick. It is said to contain no ground firebrick and to air-set quickly, presenting a dense hard surface.

New Companies.

T. J. Priestman, Limited, 94, Leopold Street, Birmingham.—Capital £25,000. Metal manufacturers and merchants, etc. Directors: T. J. and R. T. Priestman.

William E. Cotton & Sons (Brassfounders), Limited, Olympia Foundry, Bryan Street, Hanley, Stoke-on-Trent.—Capital £3,000. Directors: W. E. Hilda and H. E. Cotton.

Brooke Marine Motors, Limited, Adrian Iron Works, Lowestoft.—Capital £25,000. Directors: A. Benroy, M. A. Arbuthnot, J. W. Mawdsley Brooke, J.P., J. Mawdsley Brooke and J. Clabburn

Random Shots.

I for one had supposed that years ago the last secret in foundry practice was extracted from between the foreman's flask and the lining of his hip-pocket. . . . My supposition has been sadly fallacious apparently. A correspondent has kindly sent to me a Press-cutting from one of our "heavy-circulation" newspapers which betrays rather basely to some million and a-half readers "the closely-guarded secret of the superiority of Black Country iron and steel castings."

* * *

"Sand Secret of Trade Lead.—Method 2,000 Years Old.—None Better," declares the heading. Beneath this nutshell is printed an encomiastic reference to Staffordshire castings, and next: "A hundred-years-old sandstone grinding mill in the small hamlet of Gornal is the key to the secret of Staffordshire's reputation as the finest iron and steel casting producing centre in the world. The mill . . . employs the same system which the Egyptians used more than two thousand years ago. The sandstone is crushed between a hard circular stone base and the revolving conical stone crusher which is propelled by a horse walking round in a circular track."

* * *

The owner of the sand mill—a woman, by the way—informed the reporter who interviewed her that "mechanical science with all its improvements has failed to discover a better method of producing sand for castings than the one employed thousands of years ago. . . . The sand ground in this ancient mill is claimed by inhabitants here to be of so fine a texture that after a pattern is pressed into it the core [?] presents an even surface, which eliminates all blowholes in the metal."

* * *

What Miss Nellie Snookers at Eastbourne will have to say of the above I do *not* know! My correspondent's comment is curt: "Journalese gone mad"; and whilst "Marksman" refrains from forestalling you in criticism, he would like to say that he is profoundly puzzled why the Egyptians should have taken the trouble to grind sandstone if they had wanted sand. They could simply have transferred a mere couple of thousand slaves from pyramid work on to scavenging in the Sahara Desert. Perhaps the overseers were as niggardly with baskets for sand as they were with straw for bricks. How does one dial "Sphinx?"

* * *

Throughout the present month London will indeed be a City of Light. But I remember there appearing in a financial newspaper some twelve months ago one of Humbert Wolfe's verses which was entitled "The Uncelestial City," and which, viewed in the light of the present financial crisis, is very, very true. It read somehow like this:—

When I walk down
Threadneedle Street
I hear the multi-
tudinous feet
of those who crawl
and limp and caper
for the love of a handful
of crumpled paper.
Let them find it, or
let them lose it.
All of them die before
learning to use it.

Marksman.

The Manufacture and Properties of Malleable Iron Castings.*

Malleable iron, as considered in this Symposium, refers to the product produced by the annealing or graphitisation of "white iron" castings, in which all carbon should be present in the combined form, in such manner that the final structure of the malleable casting consists of ferrite and free carbon in the form of "temper" carbon, with substantially no combined carbon in the form of free cementite or pearlite present. The Symposium does not cover the type of malleable iron produced in European countries in which a more or less completely decarburised structure containing no temper carbon is sought; nor does it include castings produced by modifications of the original annealing cycle of a character to retain combined carbon in some desired metallographic form.

It is desirable to make clear that the terms "free carbon," "graphitic carbon" and "graphite" are synonymous, and have been used interchangeably in the Symposium. Free carbon formed during the annealing or graphitising process in the production of malleable iron from the original white iron is termed "temper carbon," which, under ordinary conditions, is nodular in form. "Primary graphite" is the specific variety of graphite which forms during freezing, and, as used in the Symposium, refers to the flake-like form of graphite.

Considering methods of manufacture, malleable iron falls broadly into two classes: that produced by the air-furnace, open-hearth or electric-furnace process, or one of the duplexing processes, and that produced by the cupola process. By far the greater amount falls in the first class, and the Symposium deals principally with that product.

All of the strength data in the Symposium have been obtained on test-bars, either separately cast (the usual custom) or attached to the casting, as distinguished from specimens cut from some portion of the casting. In common with other types of castings, the strength of a malleable iron casting as compared with that of the test-bar cast from the same metal is dependent upon a number of factors inherent in foundry operations, such as the design of the casting, the thickness of various sections, methods of gating and venting, rate of cooling and soundness of metal.

Uses of Malleable Castings.

Where strength, ductility, machinability and resistance to shock are important considerations, malleable iron castings find a wide field of industrial applications. A general classification of industries using malleable iron castings, and a list of parts in certain industries, was furnished to the committee by the Malleable Iron Research Institute, and is abstracted below.

CLASSIFICATION OF INDUSTRIES, WITH CONDENSED LIST OF PRODUCTS, IN WHICH MALLEABLE CASTINGS ARE USED.

Agricultural Implements—

Ploughs, tractors, harrows, reapers, mowers, binders, cultivators, rakes, spreaders, dairy and poultry equipment, presses, tools, pumps, wagons, fence parts.

Automobiles—

Parts for frame, wheels, springs, brakes, motor, transmission, axles, steering gear, body, accessories.

Boilers, Tanks and Engines—

Boilers, tanks, fittings, engine parts, outboard motors, Diesel engines.

Building Equipment—

Hardware for windows, doors, garage equipment, awning hardware.

Conveyor and Elevator Equipment—

Chains, buckets, pulleys, rollers, cranes, hoists, fittings.

Electrical and Industrial Power Equipment—

Motor and generator parts, pumps, stokers, electric locomotives and tractors, steam specialities, outlet and switch boxes.

Hardware and Small Tools—

Pneumatic and portable tools, miscellaneous tools, saddlery, hardware, table and kitchen utensils.

Household Appliances—

Stoves, sewing machines, refrigerators, washing and ironing machines, vacuum cleaners, dish-washing machines, oil burners, electric fans and toasters, wireless sets.

Machine Tools—

Lathes, planers, shapers, grinders, screw machines, gear cutters, drills.

Machinery for Special Uses—

Textile, cement, rubber, shoe, mining and quarrying, grinding, forging, foundry, bakery, wood-working, bottling, ice, laundry industries.

Marine Equipment—

Anchors, chains, capstans, fastenings, towing bits, hardware.

Metal Furniture and Fixtures—

Stoves, beds, desks, filing cabinets, shelving, hotel supply equipment.

Municipal, State and Public Service—

Manhole covers, posts, guard rail equipment, highway markers, transmission and telephone line fittings, electric railway fittings.

Pipe Fittings and Plumbing Supplies—

Elbows, unions, reducers, flanges, valves, bolts, nuts.

Railways—

Wide variety of parts for construction of locomotives, goods trucks and passenger coaches, guard rails, miscellaneous.

Road and Contractor's Machinery—

Rollers, excavators, cranes, hoists, tractors, graders, scarifiers, mixers, pavers.

Toys and Specialities—

Sledges, wagons, automobiles, bicycles, carriages, gun parts.

According to the Department of Commerce, there are about 150 plants in the American industry, with an estimated annual capacity of 1,350,000 tons.

Manufacture of Malleable Iron Castings.

Furnace Charge.—The furnace charge from which malleable castings are to be made usually consists of a mixture of 30 to 40 per cent. of pig-iron, 45 to 50 per cent. of sprues from a previous heat, and the balance of malleable scrap, purchased or resulting from defective castings at the plant. At times a small percentage of steel scrap is used, mainly for carbon adjustment.

Considering the common elements only, the average composition of the charge will be about as follows:—C, 2.50 to 3.00; Si, 1.20 to 1.30; Mn, 0.55 to 0.65; S, under 0.065, and P, under 0.18 per cent.

The variations depend upon whether the plant is running on a high or low tensile strength product. The elements shown in the above typical analysis of a charge must be restricted within certain limits, in order that the castings may be properly and completely malleablised. Unless the elements are present in proper proportion, the finished product will be defective.

Graphitisation by Heat-Treating Process.

In white iron suitable for graphitisation, there are but two elemental constituents, namely, the relatively soft ferrite (pure iron) and the extremely hard, brittle cementite (carbide of iron, Fe_3C), although a part of the latter is mechanically mixed with all of the ferrite to form pearlite of intermediate hardness, the balance existing as free or excess cementite. When such iron is heated to just above the critical temperature, the pearlite is transformed into austenite, the cementite remaining unchanged. Austenite is a constituent of indefinite composition with respect to carbon, capable of dissolving carbon in amounts proportional to its temperature. Accordingly, if now the temperature is raised to about 840 to 870 deg. C., the austenite will absorb as much carbon from the cementite as it can hold at that temperature. If this temperature is maintained, the austenite gives up some of the absorbed carbon, which is precipitated in the form of "temper" carbon. As this precipitation takes place, the austenite absorbs more carbon from the cementite and the cycle is repeated during the "soaking" period until all the carbon in the cementite has been dissolved. At this stage some carbon has been precipitated and the remainder is in the austenite. Then the temperature is very slowly lowered and more temper carbon is precipitated from the austenite. At the critical temperature, however, the austenite still contains the amount of carbon originally present in the pearlite of the white iron. To prevent reversion to the relatively hard pearlite in passing through the critical temperature, and to effect complete precipitation of the carbon, a very slow rate of cooling down to about 690 deg. C. must be maintained, which permits the breaking up of the austenite into ferrite and temper carbon, the final constituents of malleable iron. In brief, the malleablising process has converted hard, brittle white iron with a structure of pearlite and cementite into malleable iron, with a structure of relatively soft ferrite and temper carbon.

Coincident with the changes that take place in the structure of the iron above its critical temperature during this heat-treatment, a certain amount of carbon gradually is eliminated from the immediate surface of the casting directly exposed to the oxidising furnace atmosphere, resulting in a decarburised surface or "skin."

Melting.

In the majority of cases the mixture is melted in a reverberatory type of furnace commonly known as an air furnace, which in most instances is hand-fired, although pulverised coal or oil is now used by a large number of plants. In a few instances, melting is accomplished in an open-hearth furnace instead of an air furnace, admitting of better control. Where the cost of current is not prohibitive, a limited number of plants make use of the electric furnace.

There have appeared recently designs of small rotary furnaces of two to ten tons capacity. There are also several installations where duplexing is carried on, which serves to provide a continuous supply of metal. The metal is melted in a cupola and refined and superheated in the electric furnace or in the air furnace.

Air-Furnace Melting Process.—As the air furnace is the common type in use for melting, a brief description of the process is given. The air furnace consists of three main parts: a fire pot, hearth and stack. The roof consists of a series of rather flatly arched bungs placed side by side and held in place by adjustable metal frames which can be removed as occasion requires. The side-wall fire brick are laid against heavy cast-iron plates which form the outside of the furnace. The furnace bottom is made up with a refractory lake or sea sand, or other suitable material. Usually the metal is drained from a tap hole with pouring spout located at the lowest

* Extracted from a Symposium on Malleable Iron Castings organised by the American Foundrymen's Association and the A.S.T.M.

point of the hearth. Openings are provided to permit manipulation of the stock as it is melting down and skimming off the slag as occasion requires.

With the furnace at a high temperature from a previous heat, the furnace charge is dropped into the hearth through a temporary opening in the roof. After the air is admitted and the heat started, melting proceeds with fair rapidity. If the heat is of a size approximating 15 tons, about 3½ to 4 hours will be required before the furnace will be ready to tap. Over half the time is taken in melting down the charge to a consistency that will permit the slag to free itself from the metal. The remainder of the time is required to get the metal to a temperature sufficiently high to prevent the misrunning of the castings and to allow for the elimination of enough silicon and carbon to make sure that the fracture of the castings will be white.

Test Sprues.—As a guide to the rate of elimination of silicon and carbon after the charge has just completely melted, the furnaceman from time to time withdraws some molten metal, casts it in the form of a "test sprue," and examines the fracture. The fracture of a test sprue cast when the charge was just completely melted would be found to be dark grey, indicating the presence of graphite in large amount. Successive tests at half-hour intervals would show a heavily mottled condition, a still less amount of mottle and then rather quickly a gradual clearing up of the metal; until finally no trace of graphite would be visible in the test sprue fracture. At this point, if the initial silicon in the mixture has been adjusted properly, the bath should be sufficiently fluid to run the thinnest work on the moulding floors.

Through careful observations, the approach to adverse conditions can be recognised in time to adopt corrective measures. Through the proper use of ferro-silicon, silico-spiegel, ferro-manganese and petroleum coke, any deficiency in either silicon, manganese or carbon can be remedied.

Pouring and Cleaning.—After the moulds have been poured, the castings are shaken out, the sprues and gates broken off, and the castings cleaned in tumbling barrels or by sand blast. From the cleaning apparatus they are taken to the trimmers and inspectors, the former to remove fins and similar surface imperfections from the castings, and the latter to discard such castings as show an imperfection of any kind.

Annealing or Malleablising.

Following these operations, the castings are taken to the annealing room, where they are to undergo the second step in the process, that is, malleablising. The following description of the procedure applies to the periodic type of annealing oven.

Packing.—The castings are placed in cast-iron pots or rings and are surrounded by a packing material, which may consist of squeezer slag, crushed air-furnace or blast-furnace slag, used alone or mixed with mill scale or other form of iron oxide. In many cases sand is used. Whatever the packing material, it should be sufficiently refractory not to fuse on the castings at annealing temperatures. When one pot has been filled, another pot is superimposed on it, and filled in a similar manner; followed by a third and fourth. These together constitute what is known as a stand. Over the top of the stand are placed flat pieces of worn-out rings; and over this is plastered clay to prevent the access of oven gases to the castings. The joints between the rings likewise are luted with clay. The principal object of the packing is to make as nearly as possible a solid mass of the contents of the stands, to the end that the castings will be supported in a manner that will prevent warpage.

Annealing Period.—The stands are placed in the oven in rows with suitable clearance. Any test specimens cast to represent the castings of a given melt are suitably packed and placed in the oven with those castings. A rather slow firing is started and the temperature is increased at such rate that in some two days' time the castings are at the annealing temperature, which in some cases will be 830 deg. C. and in others about 870 deg. C. In either case this temperature is maintained for from 48 to 60 hours. At the end of this period, the temperature is lowered at a rate of not more than 4 to 5 deg. C. per hour until the temperature has fallen to around 690 deg. C., after which the oven doors can be opened and the stands removed, and the castings shaken out as soon as their temperature permits.

Types of Annealing Furnace.

The periodic type of annealing oven, to which the above description applies, predominates in general usage. In later years there has been a marked improvement in the annealing furnaces. Ovens of the periodic type for the most part are now thoroughly insulated and run under pyrometric control. These ovens are of rectangular box form with a fire pot at one end on the outside, the products of combustion passing from it to within the oven proper over a communicating bridge wall. While most of the ovens are hand-fired, oil, natural gas and powdered coal also are used. The capacity varies from about 25 to 45 tons of castings charged, and the total time required for the malleablising process will average about seven days.

One of the best ovens in use is the muffle oven, which consists of an insulated rectangular brick shell supported on the outside by steel plates, buck stays, etc. Within this shell a fire-brick muffle is constructed with a space between it and the brick shell sufficient for proper combustion of the fuel used, and so arranged with flues as to enable the flame to heat the entire surface of the muffle. In most cases oil or natural gas is used. Since the products of combustion do not come in direct contact with the castings, the necessity of packing the castings in pots is avoided, and there should be no objectionable scaling of their surface.

A continuous process of annealing is made use of by a few plants. The installation consists of a tunnel kiln, the length of which may vary from 200 to 350 ft. The stands are loaded on short cars which, when in the kiln, form its bottom. The cars, on passing through the tunnel, are subjected to a gradation of temperature so timed as to correspond to the heating cycle required. In this process the annealing time is shortened by about two days.

An electric resistance oven of a semi-continuous type has been designed in which malleablising can be accomplished in some three to four days. In one type of such an oven, the floor area of the car upon which the castings are placed is of the same rectangular dimensions as the opening in the under part of the oven, and when in position comprises the oven bottom and forms a tight seal which effectively prevents any access of air to the inside of the oven. After the annealing has been completed, the car is removed and replaced by another loaded car which is quickly raised in position. In this manner the oven can be kept quite close to the soaking temperature, saving both time and electric current.

Within the past several years various novel plans for annealing oven lay-outs have been developed, and while construction details are radically different in the individual designs, fuel economy and a shortening of the annealing cycle is attempted in each case through the use of an arrangement of separate chambers so connected by flues that the heat given up during the cooling of the castings from their soaking temperature in one chamber is heating castings in another chamber that is being brought to a soaking temperature.

Finishing.—On removal of the stands from the annealing ovens, the castings are separated from the packing material and cleaned in tumbling barrels or by sand blasting. The castings are then sorted and where necessary are ground. Inspection will then discard defectives due to breakage, poor annealing and other causes. Where economically possible, castings which have been warped in annealing are straightened.

Fallacious Ideas Concerning Malleable Iron.

Certain fallacious ideas concerning malleable iron have gained credence through statements that have appeared in the past by writers ignorant of the true character of the product or unfamiliar with the details of the process. Two of the most widespread of these are:—(1) That the malleablising process is not effective in the case of sections in excess of a thickness of approximately ¾ in.; and (2) that malleable iron is simply a superior character of grey iron.

To claim that metal in a section over ¾ in. thick cannot be completely and uniformly graphitised is to infer that after the soaking temperature of about 870 deg. C. has been maintained for from 48 to 60 hours, such a section will not have been heated uniformly through. As a matter of fact, sections up to at least 4 in. in thickness can be uniformly heated throughout under the conditions of malleablising, and graphitisation will take place throughout the entire section. Metallographic examinations made on cross-sections 4 in. and larger show no difference in structure at any part of the section, except of course at the surface where decarburisation usually takes place.

The idea that malleable iron is simply a superior character of grey iron probably originated from the fact that in the early days of the industry a large tonnage of cupola malleable iron was made, and as the cupola is the commonly used means of melting grey iron for castings, the association of ideas is probably accountable for the spreading of this statement.

From the well-known fact that the carbon in malleable iron is present as graphite, erroneous conclusions may have been drawn. It is true that graphite is a common constituent of both grey iron and malleable iron, but it is present in very different forms in the two materials. Graphite is present in grey iron in the form of flakes (primary graphite) varying in size and shape and not uniformly distributed; while in malleable iron it exists as equi-axed masses of "temper" carbon more uniformly distributed. Again, while pearlite is a usual constituent in grey iron, it should be entirely absent in malleable iron.

If comparisons are to be made, it is manifest that these should be based upon the respective physical properties of the two materials, as the user is concerned primarily with the ability of a metal to stand up in service and not with its structural or chemical composition, except in so far as the latter will influence the former.

(*To be concluded.*)

British Association: Centenary Meeting.—The British Association has now issued a handbook and time-table for the use of members and guests attending the Centenary meeting to be held in London from September 23 to 30 next. The Papers to be read before the various sections will include the following among others:—(1) Notes on a Research on Faraday's "Steels and Alloys," by Sir Robert Hadfield, Bart. (2) Metals and Alloys in Relation to Engineering Progress, by Dr. W. Rosenhain. (3) Wages, Prices and Employment, by Prof. J. H. Jones. (4) The Effect of Temperature on some of the Physical Properties of Metals, by Prof. F. C. Lea. (5) The Photographic Analysis of Explosion Flames, by Prof. W. A. Bone. (6) A discussion on Geophysical Methods of Prospecting by eight speakers. (7) A Symposium on the British Fuel Problem. (8) The New Gas Industry, by Sir David Milne-Watson. A comprehensive programme of excursions and visits to points of scientific interest in and near London has been arranged, principally for afternoons, throughout the meeting, and for Saturday and Sunday (September 26 and 27). The handbook extends to some 124 pages. The Secretary's address is Burlington House, London, W.1.

XUM

The Speed of Rotation in the Centrifugal-Casting Process.

By J. E. Hurst.

The consideration of the conditions governing the movement of liquids under the influence of centrifugal force when rotated in containers is commenced preferably by the examination of the special case of rotation about the vertical axis. The examination of this case demonstrates that under the influence of the forces due to the rotation, the internal surface of the liquid rotating in a container assumes a hollow paraboloidal form.

The diagram in Fig. 1 is an imaginary plane section through the vertical axis of a mass of liquid metal rotating about this axis in a container of the form *a*, *b*, *c*, *d*. Consider a point or element of liquid P on the inner surface of this liquid rotating at a constant and uniform angular velocity *w*. This element of liquid P at this point is subject to two forces, perpendicular to each other and which are represented in the diagram by the lines PA and PC. The magnitudes of these two forces are:—

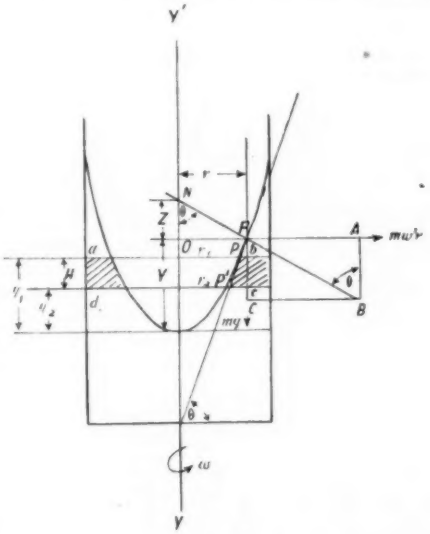


Fig. 1.

(*a*) PC, that due to gravity acting downwards = mg (m being the mass of the element P);

(*b*) PA, that due to centrifugal force acting outwards = mw^2r (r being the radius of the element P).

By the requirements of equilibrium, the resultant of these two forces PB must be normal to the surface of the liquid. Continue the line PB to intersect the vertical axis at N and the horizontal PA to intersect the vertical axis at O. Then in triangle PAB

$$\tan\theta = \frac{PA}{AB} = \frac{PA}{AC} = \frac{mw^2r}{mg} = \frac{w^2r}{g} \quad (1)$$

and in triangle NPO

$$\tan\theta = \frac{PO}{ON} = \frac{r}{x} \quad (2)$$

and by similarity of triangles

$$\frac{r}{x} = \frac{w^2r}{g} \quad (3)$$

whence

$$x = \frac{g}{w^2} \quad (4)$$

which is constant for all positions of the point P.

x is, therefore, the sub-normal, and the curve passing through P a parabola; the surface passing through P being a paraboloid about the axis YY¹.

The equation of this parabola is:—

$$Y = \frac{r^2}{2x} = \frac{w^2r^2}{2g} \quad (5)$$

in which case the distance to which the apex of the paraboloid surface is depressed is proportional to the square of the peripheral speed.

In the general case, the vertical method of casting is utilised for the production of annular shaped articles. The conditions governing the production of such annuli can be deduced from the relationship (5). Consider the annulus *a*, *b*, *c*, *d* in Fig. 1. The points P and P¹ on the interior surface have the co-ordinates r_1 y_1 and r_2 y_2.

From equation (5) the location of the points P and P¹ is defined as follows:—

$$y_1 = \frac{w^2r_1^2}{2g} \text{ and } y_2 = \frac{w^2r_2^2}{2g}$$

Generally, the distance H between the two horizontal bounding planes of the annulus is known (*i.e.*, the length, or in those cases where the annulus is short, the breadth). This distance H is equal to $(y_1 - y_2)$ and the location of the points P and P¹ can be written therefore as follows:—

$$H = y_1 - y_2 = \frac{w^2}{2g}(r_1^2 - r_2^2) \quad (6)$$

or

$$w = \sqrt{\frac{2g\,H}{(r_1^2 - r_2^2)}} \quad (7)$$

These relationships can be used in the determination of the value of the velocity (w) to produce an annulus of a height H and maximum and minimum internal diameters $2r_1$ and $2r_2$ respectively, or, alternatively, the dimensions of the annuli possible to obtain for a given value of the rotational velocity.

The above relations can be converted into a more convenient form by changing from the notation of angular velocity to the more usual revolutions per minute. Where N equals r.p.m. the expression (7) can be written

$$N = 423 \text{ (approx.)} \sqrt{\frac{1}{r_1^2 - r_2^2}} \times \sqrt{H} \quad (8)$$

where all measurements are in metric units (centimetres); or

$$N = 76.25 \text{ (approx.)} \sqrt{\frac{1}{r_1^2 - r_2^2}} \times \sqrt{H} \text{ r.p.m.} \quad (9)$$

in which the dimensions are to be taken in English units (feet). In these relationships (7), (8) or (9), it is obvious that for the condition $r_1 - r_2 = 0$, the speed N or velocity w will be infinite. For all other conditions the speed is finite, and in all practical requirements the difference either in radii $r_1 - r_2$ or diameters $(2r_1 - 2r_2)$ can be specified. For example, the maximum difference in diameter $(2r_1 - 2r_2)$ can be specified for a given range of diameters as follows:—

(*a*) for diameters of 10 mm. to 500 mm. $(2r_1 - 2r_2) = 2$ mm.

(*b*) for diameters of 10 mm. to 500 mm. $(2r_1 - 2r_2) = 5$ mm.

(*c*) for diameters of 10 mm. to 500 mm. $(2r_1 - 2r_2) = 10$ mm.

With such specified values assigned to the difference in the diameter, equations (8) or (9) can be simplified in use—by the determination of the value of the portion of the relation

$$K = 423 \sqrt{\frac{1}{r_1^2 - r_2^2}}$$

and utilising this coefficient in the simplified relationship

$$N = K\sqrt{H}$$

The values assigned to the coefficient K for the specified maximum differences in diameter given above are detailed in Table I and plotted in the diagram, Fig. 2.

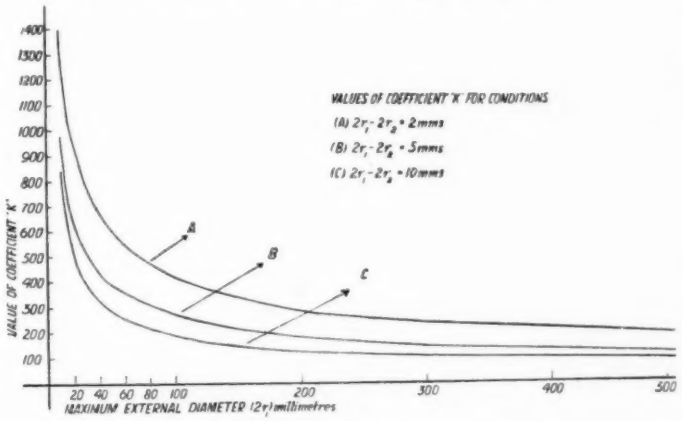


Fig. 2.

Rotation about the Horizontal Axis.

In considering the case of the rotation of a liquid about an horizontal axis, it is necessary to discuss the form taken by the surface of a liquid rotated at a constant and uniform velocity in a cylindrical container under the condition that the liquid does not completely fill the container. The case is suitably examined as previously by the consideration of a plane vertical section through the container (see Fig. 3). Consider a cylinder represented by the plane section of radius r rotating about the axis O perpendicular to the plane of the figure. The velocity of rotation, which is constant and uniform, is represented in angular measure by w, and it is assumed that the inner surface of the liquid metal which does not completely fill the receptacle is represented by the form S, S_1, S_2.

Any point or element P on the surface S, S_1, S_2 is subjected to the two forces:

(*a*) PB, that due to gravity acting downwards = mg (m being the mass of the element P);

(*b*) PA, that due to centrifugal force, acting along the line PO passing through the axis of rotation, and = mw^2r (r being the radius of the element P).

By the requirements of equilibrium, the resultant of these two forces CP must be normal to the surface of the liquid S, S_1, S_2. Continue this line CP to meet the diameter passing through

the centre at H. The following relationships exist:—

$$\frac{PB}{PA} = \frac{AC}{PA} = \frac{OH}{r} = \frac{mg}{mw^2r} = \frac{g}{w^2r} \quad (1)$$

from which $OH = \frac{g}{w^2}$ = constant.

The point H is, therefore, a fixed point, characteristic of the velocity, and, as all the normals to the curve S, S_1, S_2 pass through this point, the curve is a circle of a centre H and a radius PH, determined by the relationship

$$PH = \sqrt{\frac{g^2}{w^4} + r^2 - \frac{2gr}{w^2} \cdot \cos \alpha} \quad (2)$$

The form taken by the internal surface of a liquid rotating about the horizontal axis is thus cylindrical about an axis, centre H, at a distance OH from the axis of rotation defined by the relation

$$OH = \frac{g}{w^2} \quad (3)$$

Let OH = a (see Fig. 4).

$$a = \frac{g}{w^2} \text{ and } w = \sqrt{\frac{g}{a}} \quad (4)$$

In order that the liquid shall form a continuous hollow cylinder complete in itself within a circle of radius R, it is obvious that the

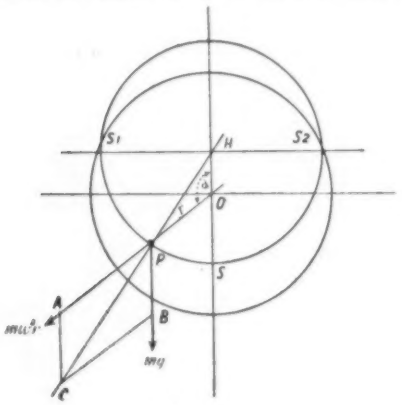


Fig. 3.

radius R must be greater than (PH + a) (see Fig. 3), i.e.:

$$R > PH + a$$

If the two radii are known, as in Fig. 4, then

$$R - R_1 \geq a$$
$$\geq \frac{g}{w^2} \quad (5)$$

which, expressed in terms of angular velocity, becomes:

$$w = \geq \sqrt{\frac{g}{R - R_1}} \quad (6)$$

More often in the practice of the production of hollow cylinders by the rotation of liquid metal about the horizontal axis, the minimum thickness (b) is specified, and the difference between the maximum and minimum thickness ($x - b$) can be established within limits. This difference ($x - b$) = $2a$, which enables us to express the relation (4)

$$w = \sqrt{\frac{2g}{x - b}} \quad (7)$$

In terms of r.p.m., where N = r.p.m., the relationships (4), (6) and (7) become

$$N = \frac{30}{\pi}\sqrt{\frac{g}{a}} \text{ r.p.m.}$$

$$N = 54\sqrt{\frac{1}{a}} \text{ r.p.m.} \quad (8)$$

$$N = 54\sqrt{\frac{1}{R - R_1}} \text{ r.p.m.} \quad (9)$$

$$N = 76.25\sqrt{\frac{1}{x - b}} \text{ r.p.m.} \quad (10)$$

In all cases the dimensions are taken in English units (feet). For the dimensions in metric units (centimetres) the expressions become

$$N = 300\sqrt{\frac{1}{a}} = 300\sqrt{\frac{1}{R - R_1}} =$$
$$423\sqrt{\frac{1}{x - b}} \quad (11)$$

The Rotation of Molten Metal.

When molten metal is poured on to the surface of a rotating mould, rotational velocity is imparted to it by virtue of the friction between the liquid metal and the mould, the internal friction between the liquid layers of metal and also by virtue of its initial velocity. The considerations in the previous section require the liquid to have assumed rotational velocity. In dealing with the rotation of liquid metals, in view of the shortness of time in which the molten metal can be maintained, and its constantly increasing viscosity during solidification, it is essential that the rotational velocity shall be acquired in the shortest possible time. The even distribution of the liquid metal is dependent on the amount of time available whilst the metal is still liquid and under the influence of the forces due to its rotational velocity.

The forces which induce rotation in molten metal carried in a container are tangential forces arising out of several conditions. The friction between the rotating container and the molten metal surface in actual contact with the container, and the internal friction or viscosity of the liquid metal, are two of the conditions which give rise to these tangential forces. The magnitude of the tangential force due to the friction between liquid and solid surfaces varies directly as the square of the velocity of movement and directly as the area of the "wetted" surface. In the case of molten metals which do not exactly "wet" the surfaces, it is probable that the magnitude of these forces is small, and that they may be considered to increase directly as the square of the velocity and the area of

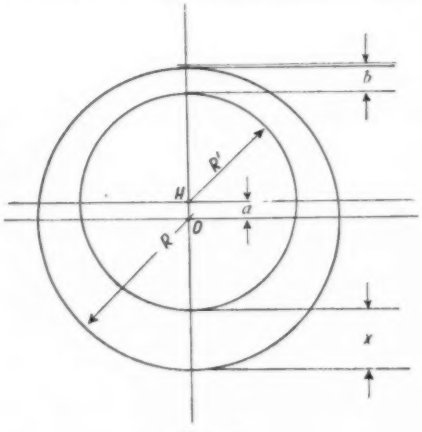


Fig. 4.

contact between the liquid metal and the container. The condition of the rotating surface of the container will exert some influence in this direction, and practical experiment provides ample evidence of such influence. It is probable that the device of roughening the surface of the mould, referred to in the patent of Chester Clark (British Patent No. 120037/1917), was designed to increase this surface friction.

The acceleration of the liquid metal is influenced also by the tangential forces due to the

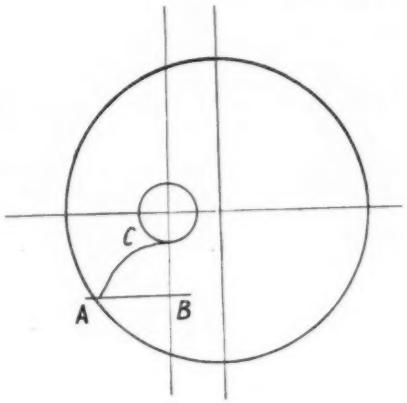


Fig. 5.

viscosity of the liquid. The relation between the tangential force and the viscosity is expressed by the equation $R = \frac{V a \beta}{S}$

Where R is the tangential force.
V is the velocity of the moving layer.
a is the area of surface affected.
β is the coefficient of viscosity.

Table I.—*Values of coefficient K for* $(2r_1 - 2r_2) = 2$ *mm., 5 mm. or 10 mm.*

$2r_1$	$2r_2$	K	$2r_1$	$2r_2$	K	$2r_1$	$2r_2$	K
mm.	mm.		mm.	mm.		mm.	mm.	
10	8	1,400	10	5	980	10	—	846
20	18	970	20	15	635	20	10	486
30	28	785	30	25	510	30	20	381
40	38	675	40	35	435	40	30	320
50	48	605	50	45	387	50	40	280
100	98	425	100	95	280	100	90	195
200	198	299	200	195	189	200	190	137
300	298	245	300	295	154	300	290	110
400	398	212	400	395	133	400	390	103
500	498	189	500	495	120	500	490	90

The total force R increases directly as the viscosity, the velocity and area of the moving layer, and the coefficient of viscosity. In the case of alloy materials, the viscosity of the liquid metal during solidification increases rapidly, and this effect is probably of great importance in determining the rapid acceleration of molten metals in commercial centrifugal-casting processes. Abundant evidence of this is encountered in practice. In the production of excessively thick castings in cast iron, where considerable time is necessary for the complete solidification of the metal, a demonstration of this effect can be obtained readily. When a large mass of metal is poured into a mould rotating at a constant speed and rotating about an horizontal axis, the whole of the molten metal is not picked up immediately by the rotating mould. As time elapses and the temperature of the molten metal falls, more and more of the liquid steadily assumes the rotational movement. By slow pouring or the utilisation of cold metal, it is often possible to produce castings of exceptional radial thickness at a rotational speed lower than that which would be necessary with hotter metal. A further confirmation of this is to be found in one of the Lavaud Patents (British Patent No. 160239), describing a more effectively cooled mould built up in laminated sections. Whereas the speed for the production of a 6-in. dia. pipe utilising the normal mould construction is 1,200 r.p.m. (31.33 ft. per sec.), it is stated that by the use of the more effectively cooled mould it can be reduced to 600

r.p.m. (15.66 ft. per sec.). Whilst, in so far as the author is aware, this latter form of mould is not adopted in commercial practice, the influence of the more effective cooling on the rotational speed desired is due probably to the above-mentioned effect.

With certain exceptions, in commercial centrifugal-casting processes the molten metal is applied to the rotating mould with a certain initial velocity. Obviously, if the initial velocity of the metal stream applied to the mould is the same in magnitude and direction as that of the mould at the point of application, then the time required for the acceleration of the molten metal due to the rotation of the mould is nil, and the previous considerations of surface friction and viscosity vanish. The values of the initial and final metal velocities can be determined in practical cases by an examination of the pouring position. For example, in the horizontal axis of rotation case (see Fig. 5) the metal stream issuing from the pourer spout describes a parabolic path. Observation of the positions A and C fix the dimensions AB and BC which are proportional respectively to ut and $\frac{1}{2}gt^2$

where u = the initial stream velocity at C.
g = the acceleration due to gravity.
t = the time in seconds.

The time t derived from the relation $BC = \frac{1}{2}gt^2$ substituted in the relation $AB = ut$ fixes the value of the initial velocity. The final velocity at A is derived from the well-known equations

$$S = ut + \tfrac{1}{2}gt^2$$
$$V^2 = u^2 + 2gS$$

where V is the final stream velocity at the point A.

The foregoing points are sufficient to demonstrate the additional factors which have an influence on the rotational speeds. The manner in which the molten metal is applied to the mould, the character of the mould surface and material, whether metal or sand, all are of importance in determining the time required to accelerate the metal to the rotational velocity of the mould. For example, in sand moulds or in moulds which are maintained at high temperatures, the period required for the solidification of the molten metal is prolonged. In these cases the allowable time limit for the acceleration of liquid metal is likewise prolonged.

Table III.—*Relationships of Speed to Diameter.*

R.	$\sqrt{R}$.	$\frac{1,675}{\sqrt{R}}$.	Peripheral velocity.	$\frac{1,550}{\sqrt{R}}$.	Peripheral velocity.
in.		r.p.m.	f.p.m.		f.p.m.
2	1.414	1,180	1,235	1,095	1,150
4	2.000	837	1,750	775	1,630
6	2.449	685	2,150	632	1,985
12	3.464	485	3,040	447	2,750
24	4.898	343	4,300	318	3,990
36	6.000	279	5,250	258	4,850

The author has previously given a minimum speed condition of 1,200 ft. per min. peripheral velocity. This speed has been determined by experiment in the production of castings of from 4 to 12 in. dia. and on short lengths operating with hot cast-iron moulds having an internal surface temperature of approximately 550 to 600 deg. C. and rotating about the horizontal axis. Below this speed irregularity of dimensions was constantly encountered in the castings. Under somewhat similar mould conditions, but operating with moulds of 36 in. dia. and 12 ft. in length, pouring with the helical-edged pourer, the molten cast iron was constantly and uniformly accelerated at a speed of 166 r.p.m., corresponding to a peripheral velocity of 1,500 ft. per min. (25 ft. per sec.).

A collected list of rotational speeds which have been published from time to time by various authorities in relation to several of the different processes is given in Table II. There is a considerable variation in both the magnitude of the speeds and also in the considerations governing their adoption. In the case of the Lavaud process, the rotational speeds are subject to certain special considerations, due to the method of pouring. The complete pouring of a mould in this case is brought about by the longitudinal movement of a metal stream of comparatively small width over the surface of the rotating mould. It is necessary to synchronise this longitudinal movement with the rotational speed of the mould. The investigations of Dr. Pardun on a machine of this type producing castings 17 ft. in length, 12 in. in internal diameter and ½ in. radial thickness, showed a minimum speed of 400 r.p.m. (1,260 ft. per min.) to be necessary to eliminate spiral markings on the surface of the castings. This was considered to be the critical speed under the particular conditions of casting. The spiral markings are due principally to the relation between the lead in the longitudinal traverse of the metal stream and the speed of rotation. In these investigations it was also found that the minimum speed at which molten iron failed to be picked up was 240 r.p.m. (75.3 ft. per min.). In certain other instances, *e.g.*, Cammen, the speed relationship has been determined by considerations of uniform centrifugal pressure. The relationships of speed to diameter, given by Cammen as $\frac{1,675}{\sqrt{R}}$ and Moldenke as $\frac{1,550}{\sqrt{R}}$, are given for R from 2 to 36 in. in Table III. In both these instances the peripheral velocities increase with increase in diameter of casting.

Aluminium die castings can be cleaned for plating by immersing them for 30 sec. in a bath composed of 1 gallon of water, 1 ounce of sodium carbonate and 1 ounce of trisodium phosphate.

Table II.—*Collected List of Rotational Speeds of Various Processes.*

Process.	Axis of rotation.	Mould material.	Castings.	Speed N = R.P.M.	Dia. of casting.	Remarks.	Authority.	Source.
Lavaud ..	—	Metal ..	Pipes ..	550–750	6 in.	Constant speed up to 12 in. dia.	—	—
Lavaud ..	—	Metal ..	Pipes ..	250	—	Diameters equal to or greater than 30 cm.	Corbelet ..	La Science et la Vie, September, 1922.
Lavaud ..	—	Metal ..	Pipes ..	750	8 in.	—	—	—
Lavaud ..	—	Metal ..	Pipes ..	300–500	—	—	Schwartz ..	Die Giesserei, February, 1930.
Cammen ..	Horizontal	Metal ..	Tubes ..	$\frac{1,675}{\sqrt{R}}$	R = inside rad. in in.	Gives constant pressure ..	Cammen ..	Amer. Soc. M.E., May, 1922.
Chester Clark	Horizontal	Metal ..	Cupro-Nickel	1,050	14 in.	Whether int. or ext. dia. not stated	Chester Clark	Brit. Pat. No. 120037 (1917).
Sand spun ..	—	Sand ..	Pipes ..	$\frac{1,550}{\sqrt{R}}$	R = inside rad. in in.	—	Moldenke ..	F.T.J., September 25, 1924.
Millspaugh ..	Horizontal	Metal ..	Tubes ..	1,000	14¾ in. × $\frac{15}{16}$ in. thick .	12 ft. 1¼ in. length	—	—
Wasson ..	Vertical ..	Sand ..	Piston rings	300	8 in. to 17 in. ..	Stated constant pressure of 100 lbs. per sq. in.	—	F.T.J.
Lavaud ..	—	Metal ..	Pipes ..	600	6 in.	Special design of mould ..	—	Brit. Pat. No. 160239.
Sand spun ..	—	Sand ..	Pipes ..	900	6 in.	—	—	—
David Brown	Vertical ..	Steel and sand cores	Bronze ..	450–950	—	Giving a minimum pressure of 45 lbs. per sq. in.	Rowe ..	J. Inst. Mets., No. 2, 1926.

Catalogues Received.

Valves.—Hopkinsons, Limited, of Huddersfield, in List No. 3135, describe and illustrate a complete line of parallel-slide valves. The main features are that it presents a full-way uninterrupted passage through the valve equal to the internal diameter of the pipe, elimination of wedging action, accessibility and durability.

Steel Tools.—We have received from Edgar Allen & Company, Limited, Imperial Steel Works, Sheffield, a leaflet setting out 15 advantages of Stag Major superweld tools, together with a complete cutting-tool chart, showing the shapes and standard sizes which are normally carried in stock. The outstanding feature of these tools is that they have solid pieces of Stag Major high-speed steel properly welded on to a high-grade steel shank.

Glassware.—We have received from Butterworth Brothers, Limited, Newton Heath Glass Works, Manchester, a copy of their latest catalogue, "Anything in Glass." It typifies the class of catalogue that is kept, as everything is clearly illustrated and priced. Whilst admitting that the first duty of any person responsible for the conduct of a department of a factory is to carry spares for every piece of glass used in association with machines, we realise that occasions do arise when spares are urgently required, and it is in this connection we suggest that the value of the catalogue could be enhanced by the inclusion of a telegraphic code. We suggest that buyers receiving this catalogue should see that it is inspected by the chief metallurgist, as there are a number of items on pages 21 and 22 which the laboratory is probably buying through a retailer at higher prices.

Sand Preparation.—Messrs. J. W. Jackman & Company, Limited, Vulcan Works, Blackfriars Road, Manchester, in leaflet No. 54 describe a new development in sand preparation. The machine described and illustrated sieves, mixes, mills, disintegrates and delivers continuously a stream of fully-prepared sand. Sieving is effected by a vibratory sieve fed from a conveyor or by hand. The mixing is carried out by paddles in an enlarged end of the barrel, whilst for milling an entirely new principle involving rolling by means of a spiral is utilised. This involves a differential speed between the barrel and the spiral. The disintegrator paddles are fitted with rubber wearing faces of a readily renewable character, whilst the discharge is so arranged that it can feed wheel barrow, truck, the top of a hopper or the boot of an elevator. Three sizes are available. These are roughly specified, and code words have been provided. This leaflet should certainly be obtained as relating to a really novel development in foundry practice.

Strength Properties of Cast-Iron Test-Bars Cast Vertically and Horizontally.

The effect of the pouring method upon the strength of grey cast iron has been recently investigated by K. L. Zeyen.* The iron was melted in an acid-lined high-frequency furnace, heated to about 1,400 deg. C., and cast at 1,350 deg. C. in undivided dry-sand moulds faced with graphite, each mould containing three test-bars, 30 mm. (1,18 in.) in dia. and about 700 mm. (27.6 in.) in length. Of each heat, one mould was cast vertically (bottom cast), and another horizontally. In the latter case the ends of the moulds were closed by auxiliary moulds containing the down-runners and risers (see Fig. 1). The transverse test was made on the bars in the as-cast condition at 600 mm. (23.65 in.) centres. The tensile-test samples were cut from the lower halves of the bottom-cast bars, and with the horizontally-cast bars from the halves adjoining the inlet. The Brinell hardness was determined on cross-sections near the transverse-test fracture. The

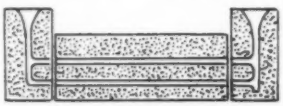


Fig. 1.—Mould for Horizontally-Cast Bars.

present instance can be explained by the fact that the auxiliary moulds at the ends prevented the bars from contracting freely. This has, according to Campion, a bad effect upon the strength and deflection.

Further, tensile tests were made with samples cut from the halves remote from the inlets, the results being recorded in Table II. With the bottom-cast bars, no appreciable difference in strength was found. Therefore, with this pouring method, it is of no importance from which part of the bar the sample is cut. However, with the horizontally-cast bars, higher strength values were found which equalled those of the bottom-cast bars. Other investigators have also shown that the strength of cast iron is affected by the position of runners and risers. As to the effect of top and bottom pouring, the author has shown, with the aid of the experimental data of other workers, that, in general, the bottom-cast bars show somewhat better strength properties. Heat No. 4, which had been heated to about 1,550 deg. C. before pouring, was affected by the pouring method in the same way as the other heats. However, the strength values found with this heat were by far inferior to those of heat No. 7, which had about the same composition. With heat No. 4 the graphite, though in a finely divided form, had accumulated in a network around the long dendritic mixed crystals, whereas with the other heats it was uniformly distributed over the whole area. In a former investigation, the author has shown that the strength of low-carbon cast iron is impaired by high stewing temperatures.† The heats Nos. 5 and 6 (Table I) show that by alloying nickel and chromium the tensile strength could be improved; the results of the transverse test were not uniform.

Table I.

Heat No.	Composition, Per Cent. C.	Si.	Mn.	S.	P.	Ni.	Cr.	Pouring method.	Transverse strength, tons/sq. in.	Deflection, in.	Tensile strength, tons/sq. in.	Brinell number, 10/3,000/30.
1	3.8	1.49	0.87	0.079	0.28	—	—	Top .. .. cast	18.7	0.575	9.46	149
								Bottom .. .. ,,	20.1	0.464	9.71	158
								Horizontally .. ,,	17.0	0.394	8.57	150
2	3.52	1.51	0.87	0.079	0.30	—	—	Top .. .. ,,	18.5	0.520	13.3	174
								Bottom .. .. ,,	21.9	0.429	14.1	183
								Horizontally .. ,,	19.9	0.394	12.9	177
3	3.3	2.12	0.85	0.074	0.33	—	—	Top .. .. ,,	20.3	0.448	15.6	179
								Bottom .. .. ,,	23.3	0.409	15.8	188
								Horizontally .. ,,	21.5	0.378	15.5	181
7	2.83	1.74	0.82	0.067	0.18	—	—	Top .. .. ,,	21.5	0.339	23.4	203
								Bottom .. .. ,,	26.0	0.327	24.0	220
								Horizontally .. ,,	24.8	0.315	22.3	213
5	3.52	1.43	0.75	0.067	0.33	0.86	0.25	Top .. .. ,,	18.5	0.422	16.3	183
								Bottom .. .. ,,	19.4	0.394	17.3	193
								Horizontally .. ,,	19.2	0.370	15.6	185
6	3.21	1.66	0.87	0.08	0.32	0.88	0.25	Top .. .. ,,	21.5	0.425	17.8	207
								Bottom .. .. ,,	25.6	0.366	17.9	214
								Horizontally .. ,,	23.3	0.366	17.0	205
4	2.8	1.99	0.81	0.074	0.3	—	—	Top .. .. ,,	20.8	0.362	18.0	205
								Bottom .. .. ,,	23.4	0.331	18.2	219
								Horizontally .. ,,	21.5	0.268	17.3	214

top-cast down-runners for the bottom-cast bars, which had the same dimensions, were also tested. From Table I, where the composition and the strength (average values) of the heats investigated are recorded, it can be seen that the bottom-cast bars showed higher values of transverse strength, deflection and tensile strength than did the horizontally-cast bars; the Brinell hardness, too, was somewhat higher. With the top-cast down-runners, the lowest transverse strength and Brinell hardness were obtained, and the highest deflection, whereas the tensile-strength values were between those of the two other groups of bars. The low strength values of the down-runners can be explained by the fact that they had solidified the slowest, because by running the total quantity of molten iron through them, the sand around them had been preheated to a great extent. The graphite content of the runners was about the same as that of the other bars. With heat No. 3, the following values were obtained:—2.39 per cent. (down-runner), 2.38 per cent. (bottom cast), and 2.42 per cent. (horizontally cast); and with heat No. 7: 1.87 per cent., 1.83 per cent. and 1.81 per cent. However, under the microscope, a slight coarsening of the graphite was noted in the case of the runners.

The lower strength values of the horizontally-cast bars were caused by the lower cooling rate resulting from the closed ends of the moulds. Slow cooling improves the mechanical properties

Table II.

Heat No.	Pouring method.	Tensile strength, tons per sq. in. Test-sample cut from the half Near the inlet.	Remote from the inlet.
1	Bottom cast ..	9.71	9.71
	Horizontal cast	8.57	9.58
2	Bottom cast ..	14.1	13.65
	Horizontal cast	12.9	13.4

* "Die Giesserei," 1931, No. 9.

† "Die Giesserei," 1929, No 33; see Foundry Trade Journal, June 5, 1930.

Publication Received.

Nickel Bulletin, No. 8, Vol. 4.—Whilst we do not, as a rule, acknowledge the receipt of periodicals which reach us regularly, we are making an exception in this case to call attention to an excellent article on "Nickel-Steel Tools in Engineering Construction and Maintenance." Much of the matter covers a research by Sir Henry Fowler, of the London Midland & Scottish Railway, and discloses that for fettling all classes of castings, except white iron, nickel steel retains its edge much longer than plain carbon steel, which fact introduces economies, as a chisel may last a whole day without being resharpened. The composition advocated is 0.38 to 0.42 C., 0.6 (max.) Mn and 3.0 to 3.5 per cent. nickel. It requires only a simple heat-treatment, consisting of heating the tool to 900 to 950 deg. C., and quenching the cutting portion in raw linseed oil for about 4 in. upwards. Grinding must precede heat-treatment, and final dressing to the edge should be given by a file. A very striking illustration accompanies the article, as it shows a nickel-alloy-steel chisel driven cold right through a 2½-in. block of mild steel.

Data Relating to a Pig-iron Casting Machine.—In a recent issue of "Stahl und Eisen" a report of the Blast Furnace Committee of the Association of German Ironmasters contains the following data relating to a machine used for teeming pigs. Iron is tapped eight times in 24 hours, and the daily average output is 240 metric tons. Each cycle of tapping, teeming, cooling the pigs, removing the pigs and preparing the bed for the next lot occupies from 140 to 160 min. The weight of metal tapped each time is 33.5 tons, and the average weight of the pigs is 43.5 kgs. (about 95.7 lbs.). The consumption of electric current is 13 kw.-hrs. As only one-half of the teeming shed is made use of, the daily output could be raised easily to 700 tons, and with some alteration of the crane and the magnets to 800 or 850 tons.

The Influence of Bismuth on Cast Iron.*

By E. K. Smith and H. C. Aufderhaar.

Bismuth is one of the most interesting of metals with most unusual properties, yet very little is commonly known of its characteristics. It is highly resistant to acids, has a very low melting point and is strongly diamagnetic. It is mined by itself, and in America is produced as a by-product of the production of gold, silver, lead and copper. Its quoted price to-day is 6s. to 7s. a lb., but it is a fairly safe conjecture that this unusual metal could be produced at an even lower price, should consumption warrant larger production.

Literature on Bismuth.

Bismuth is used extensively in pharmaceutical preparations and in combination with lead, tin and cadmium in a series of alloys of extremely low melting point, some of which are molten at the temperature of boiling water. However, the literature shows but little on the effect of bismuth on ferrous metals. Marx stated (Schweigg, "Journal," 58, page 471) that he could not alloy bismuth and iron together. Henkel and Gellert announced that they made a brittle bismuth iron (Gmelin-Kraut, 1897, BD3 S 427). The most noteworthy research was that of Isaac and Tammann (Isaac and Tammann, "Zeitschrift Anorganische Chemie," 55, 1907, page 58) who made various melts of bismuth in iron and drew the constitutional diagram, showing the complete immiscibility of the two metals in both solid and liquid condition.

Burgess and Aston made melts of bismuth in steel ("Transactions" Electrochemical Soc., 15, 1909, page 369), the former in varying proportions up to 10 per cent. They reported unusual electrical properties in the steel, which, however, was not analysed for bismuth, and the probability is that little bismuth remained in the metal. G. Hägg reports X-ray studies of iron and bismuth (Royal Soc. Sci. Upsala, 7, 1929, page 1). A very complete digest on sources, properties and uses of bismuth is contained in the American Bureau of Standards circular No. 382 "Bismuth," by J. G. Thompson, research associate.

Methods Used.

Raw materials used by the authors for experimental work to study the effect of bismuth on cast iron consisted of various grades of cast iron and extremely pure bismuth, which analysed over 99.9 per cent. metallic bismuth.

(1) *Ladle Additions.*—Preliminary experiments were conducted by addition of bismuth in amounts up to 2 per cent. in 50-lb. ladles of cast iron. These tests were with a view of trying bismuth on cast iron under actual foundry conditions. In each cast a standard tensile and transverse test-bar was poured.

(2) *Crucible Melts.*—In order to have more accurate control of iron composition, pouring temperature, etc., a series of melts was made in crucibles, similar amounts of bismuth being added. After suitable time for any possible reactions to take place, standard test-bars were poured.

(3) *Electric-Furnace Melts.*—In order to study the effect of bismuth on highly superheated cast iron, several melts were made in a 250-lb. 'Lectromelt furnace.

In general, bismuth melted immediately and dropped to the bottom of the molten iron. Copious fumes were given off, presumably bismuth trioxide. A point noted by the moulder handling the metal was that the bismuth-treated metal had much more "life" than the untreated. In fact, ladles of iron apparently on the verge of solidification, when treated with about ½ per cent. bismuth seemed to be revivified, the surface becoming clear and the iron being held in the ladle for a considerable period, before it became necessary to pour the test-bars.

Another practical point was that the moulding sand peeled very readily from the bismuth-treated iron, regardless of the temperature at which the metal was poured. This was not the case with the untreated bars.

Effect of Bismuth on Physical Properties.

An attempt was made to determine the effect of increasing amounts of bismuth on the physical properties of the cast iron. In each series of experiments, it became apparent that the effect of bismuth was not cumulative. Up to about 0.3 per cent., bismuth had increasing effect, while from 0.3 up to 3 per cent. the effect was of the like order, regardless of the excess bismuth present. Therefore, all subsequent experiments were based on the addition of 1 per cent. bismuth.

Table I gives a number of the characteristic samples. In a number of cases, however, the effect of bismuth was erratic, apparently due to lack of oxides in the iron.

TABLE I.—*Mechanical Properties of Bismuth Cast Iron.*

Bismuth added. Per cent.	Tensile strength. Tons per sq. in.	Transverse strength. Lb.	Brinell hardness.
0 ..	17.3	4,200	241
0.5 ..	11.8	3,400	196
0.1 ..	6.4	2,200	187
0.2 ..	5.6	1,900	187
0.3 ..	4.5	1,600	170
1.0 ..	4.6	1,700	163

In general, the effect of bismuth on cast iron is as a softener; strength is lowered as is the Brinell hardness number.

The above Brinell figures were all taken at a point ½ in. below the surface of the arbitration bar. However, most of the bismuth-treated samples showed an outer edge of moderate hardness, while the interior of the bar was decidedly softer, the differential being much greater than in the pearlitic cast iron.

Machinability Test.

It was noticed that the bismuth-treated bars could be drilled more easily than the untreated bars. Accordingly, a few machinability tests were run on treated and untreated bars of similar Brinell hardness. The machinability figure was arbitrarily taken as the penetration of a ⅜-in. standard high-speed drill running at 400 r.p.m. under total load of 136 lbs. The results are shown in Table II.

TABLE II.—*Influence of Bi on the Machining Properties of Cast Iron.*

Bismuth added. Per cent.	Brinell hardness.	Penetration in millimetres per min.
0	179	24
2	179	28
1	183	38
2	179	40

Machinability figures would tend to substantiate practical observations, namely, that bismuth increased machinability more or less regardless of the Brinell hardness figure.

Chemical Analyses.

Typical iron used in most of the experiments had the analyses shown in Table III.

TABLE III.—*Analyses of Bi Cast Iron.*

	Per cent.			
	a.	*b.*	*c.*	*d.*
T.C.	3.03	3.03	3.00	3.03
C.C.	0.49	0.23	0.14	0.20
Gr.C.	2.54	2.80	2.86	2.83
Si	2.14	2.16	2.16	2.19
Mn	0.36	0.34	0.34	0.33
S	0.100	0.093	0.096	0.103
P	0.710	0.710	0.694	0.700
Bi (added) ..	0.0	0.20	0.30	1.00

The above series was made in order to determine the effect, if any, on chemical analysis of one type of cast iron. Bismuth reduced combined carbon and increased graphitic carbon, but had no further effect on chemical analysis.

In an attempt to account for the softening effect, analyses were run on the bismuth-treated iron for the element bismuth. In all, some 14 attempts were made to determine bismuth in the treated iron samples, results showing from 0 to 0.002 per cent. on various samples.

As a check on samples of treated metal showing no bismuth by analysis, concentrated solutions of these metals were made and volatilised in an arc lamp. In all cases, the bismuth-treated metal showed the characteristic spectrum of bismuth while untreated samples showed no such lines.

Crucible Melts.

In order to get more conclusive information as to the possible solubility in molten or solid cast iron, or even its solubility in any of the components of cast iron, a number of crucible melts were made, using equal parts of bismuth and cast iron. The iron was first melted and then the bismuth stirred in. At intervals the whole mixture was violently stirred, so as to ensure complete mixing. After one-half hour the melt was permitted to settle and solidify, cooling in crucible. The cold ingot was sawed vertically, which revealed the bismuth as being below, owing to its high gravity.

Drillings were taken from the iron half of ingot, and analysis made for bismuth, 0.63 per cent. being found. A further investigation along similar lines was made, but with the melt held for some time to permit more complete settling of the bismuth. When thoroughly quiet, a small amount of the iron was poured into cold water, with the thought that more bismuth might be held by the iron in this condition. After solidification, drillings were taken from the iron and from the bismuth, and analyses showed that the iron shot contained a trace of bismuth; the iron drillings 0.27 per cent. of bismuth; and the bismuth 0.18 per cent. of iron.

Although the microstructure of the cast iron shows no evidence of alloying except just at the junction between the two metals, analyses of the cast iron on two different 50-50 melts showed 0.27 per cent. and 0.63 per cent. bismuth. On the other hand, cast iron which had been treated with from 0.3 to 1 per cent. bismuth, showed practically no bismuth by analysis.

This apparent discrepancy is probably due to small globules of bismuth which became separated from the lower part of the 50-50 melt and were carried by currents upward through the molten iron. In several cases globules of bismuth were found on the surface of the iron; in other cases, fine particles, apparently of bismuth, were noted in the centres of the phosphide eutectic. It seems probable that the bismuth, shown by analysis in the cast iron of the 50-50 melts, is held mechanically.

Microstructure.

While bismuth does not always affect cast iron uniformly, as a rule it has a softening effect on physical properties, and an effect rather unexpected to the authors on the form of the graphite. It was expected that the graphite in the soft bismuth-treated metal would be of the large-flake variety, such as is sometimes found in annealed

* Extracted from "The Iron Age."

samples, or where aluminium or titanium have been used as deoxidisers.

Bismuth in general gives very short flakes of graphite, associated with ferrite in the centre of the casting and pearlite on the outer edge. The structure of "ferrite and small graphite," coupled with a sooty fracture and a great tendency to chill on the outer edge, is very characteristic of the bismuth cast-iron fracture, and seems to have a strong resemblance to a similar series of cast irons reported by Norbury in the "Journal" of the Iron and Steel Institute, 1929, page 444 and following; also reported by the same author, "Journal" of the Iron and Steel Institute, 1930, page 368 and following.

As it seemed probable that an intercrystalline substance might have some relation to the extreme weakness of the metal coupled with its lack of shock resistance, a sample was carefully polished and then broken, and some of the grains were completely separated from the surrounding iron and cracks invariably follow the grain borders.

As the addition of bismuth to most cast irons resulted in a great softening effect, coupled with breaking up of carbides, it would seem reasonable that the effect is due to deoxidation of the cast iron. Bismuth trioxide, formed as a by-product, is stable, and it seems probable that a good part of this is left at the grain borders, forming planes of weakness. The bismuth trioxide has a specific gravity of 8.86; so it would seem reasonable that at least part of the bismuth trioxide would stay in suspension.

Theoretical Considerations.

A number of theories were advanced to explain the unusual effect of bismuth in softening cast iron. It has been stated that the extraordinary weakening effect of bismuth on copper is due to a very small amount of metallic bismuth which is forced to the grain borders on solidification, causing planes of brittleness. (Greaves and Wrighton, "Metallography," page 96.) Bismuth apparently has the same effect on gold.

At first sight a similar effect seemed probable with cast iron. As there is no alloying between bismuth and iron and no solution of bismuth in iron, either in the solid or liquid state, it would seem highly probable that the change in physical properties is due to intercrystalline phenomena. The theory of intercrystalline films of bismuth metal had to be abandoned for several reasons. The very low proportion of bismuth found by analysis in the treated cast irons would deny the possibility of any continuous metallic bismuth films. Furthermore, a sample of cast iron thoroughly treated with bismuth was suspended in tension and maintained well above the melting point of bismuth. It seems probable that, were any appreciable intercrystalline films of metallic bismuth present, the metal would have softened.

The most probable theory to explain the effect of bismuth would seem to be that it acts primarily as a deoxidiser. This would explain the obvious fact that the metal is greatly softened, due to the decomposition of pearlite and the formation of a "small graphite and ferrite" structure. The probable inclusion of some bismuth oxides as intercrystalline inclusions might account for low shock resistance.

In order to check the effect of bismuth on cast iron known to be oxidised, a number of crucible heats were made, in which materials certain to give oxidised metal were used. One heat contained 30 per cent. cast iron borings with the remainder cast scrap. Bars from this mixture showed white fracture, while bars poured after 1 per cent. of bismuth had been added showed heavily mottled fracture.

Another crucible melt was made with the addition of badly burned grate bars. In this case the first bar poured had a mottled fracture. A bar poured after the addition of 1 per cent. bismuth showed a soft grey fracture in the centre, surrounded by a $\frac{3}{16}$-in. white edge.

Effect of Bismuth on Malleable Iron and Steel.

In order to check the theory that bismuth acts as a deoxidiser, various amounts were added to malleable iron and to steel. The results were inconclusive, owing to the fact that the bismuth boiled at a lower temperature (1,436 deg. C.) than that of the molten malleable iron or steel. The addition of bismuth to cast iron is usually accompanied by the evolution of fumes, presumably bismuth trioxide, but in the case of malleable iron and steel, the entire addition of bismuth volatilised at once, having little apparent effect on the metal.

Possible Uses.

The question of commercial uses for bismuth in cast iron is outside the scope of this Paper. However, one or two possibilities might be mentioned:—

(1) It might be used as a deoxidiser for metal known to contain excess oxides—such as mixtures in which thin or rusty scrap, borings and turnings or burned metal have been used.

(2) In the present era of high-test cast iron it might be desired to pour certain castings with very soft iron. This could apply where the iron required little strength or shock resistance but would be subjected to extensive drilling, etc.

(3) It has been suggested that iron with such low impact resistance might be subjected to fragmentation tests.

(4) It was noted that bismuth-treated iron had more "life" and presumably more fluidity. At the same time, test-bars poured with such metal shook out practically clean from adherent sand. A possible field for investigation would therefore be the effect of bismuth iron for castings of very light section where fluidity and trueness to pattern and freedom from sand of the resulting casting might be an advantage.

Acknowledgments.

The authors wish to acknowledge the kind co-operation of the American Smelting & Refining Company, New York, and the Cerro de Pasco Copper Corporation, New York, both of whom furnished bismuth of 99.9 per cent. and over, purity for the experimental work, as well as check analyses on some of the metal.

Patent Specifications Accepted.

The following list of Patent Specifications accepted has been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The last numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

17,660. Wade, H. (Lewis, E. S.). Foundry moulding machines. 349,790.
26,351. Piel, C. Casting of metals. 349,863.
7,611. Neesham, J. B. Foundry moulding machines. 350,020.
7,625. Hall, H. C., and Bradbury, T. F. Aluminium alloy. 350,022.
8,093. Colville & Sons, Limited, D., and McCance, A. Manufacture of steel. 350,048.
11,791. Johnson, J. Y. (I. G. Farbenindustrie Akt.-Ges.). Recovery of molybdenum from mixtures of molybdenum or molybdenum compounds with other metals or metal compounds. 350,135.
22,010. Valley Mould & Iron Corporation. Ingot moulds. 350,302.
29,277. Ruselite Corporation. Aluminium alloys and method of producing the same. 350,357.
7,656. Hall, H. C., and Bradbury, T. F. Aluminium alloy. 350,447.
8,340. Parker Rust Proof Company. Producing a phosphate coating on metal. 350,565.
8,128. International Nickel Company, Inc. Manufacture of ferro-nickel magnetic alloys. 350,603.
19,927. Hirsch, Kupfer-und Messingwerke Akt.-Ges. Copper-silicon-zinc alloy. 350,750.
35,018. Felten & Guilleaume Carlswerk Akt.-Ges. Ingot moulds. 350,876.

Iron and Steel Institute.

SWANSEA MEETING PROGRAMME.

In accordance with previous announcements, the autumn meeting of the Iron and Steel Institute will be held at the Royal Metal Exchange, Swansea, on Tuesday, Wednesday, Thursday and Friday, September 29 to October 2. The programme of the meeting was published in our issue for July 30. The following is a list of Papers which it is expected will be submitted to the meeting:—

(1) "The Equilibrium of Certain Non-Metallic Systems," Part I, by J. H. Andrew, W. R. Maddocks and D. Howat; Part II, by J. H. Andrew, W. R. Maddocks and E. A. Fowler.

(2) "Alloys of Iron Research. Part X.—The Chromium-Iron Constitutional Diagram," by F. Adcock.

(3) "The Diffusion of Tin into Iron with Special Reference to the Formation of Columnar Crystals," by C. O. Bannister and W. D. Jones.

(4) "The Structure of Nodular Troostite," by N. T. Belaiew.

(5) "The Effect of Molybdenum on Medium-Carbon Steels Containing 1 to 2.5 per cent. of Manganese," by G. Burns.

(6) "Production Economy in Iron and Steel Works. Part II.—Costs of Production," by O. Cromberg.

(7) "The Surface Hardening by Nitrogen of Special Aluminium-Chromium-Molybdenum Steels on a Production Basis," by W. H. Cunningham and J. S. Ashbury.

(8) "The Constitution of the Iron-Tin Alloys," by C. A. Edwards and A. Preece.

(9) "The Effect of Surface Conditions Produced by Heat Treatment on the Fatigue Resistance of Spring Steels," by G. A. Hankins and M. L. Becker.

(10) "The Influence of Silicon on Nickel Steel," by R. Harrison.

(11) "Mottled Tinplates," by J. C. Jones.

(12) "The Solidification and Crystallisation of Steel Ingots: The Influence of the Casting Temperature and the Undercooling Capacity of the Steel," by B. Matuschka.

(13) "A Critical Study of the Origin of the Banded Structure of a Hot-Worked Hypo-Eutectoid Steel," by F. C. Thompson and R. Willows.

It is expected that, subject to the direction of the President, the Papers will be taken in the following order:—

Tuesday, September 29.

Papers Nos. 8, 3, 5 and 10.

Wednesday, September 30.

Papers Nos. 11, 1, 2, 9 and 12.

Thursday, October 1.

Papers Nos. 6, 7, 4 and 13.

Railway Facilities.—By the courtesy of the railway companies, members attending the meeting will be able to obtain return tickets to Swansea at a single fare and a third on presenting at the booking office of their station of departure, a voucher signed by the Secretary of the Institute (28, Victoria Street, Westminster, S.W.1), who will be pleased to forward such vouchers on application.

Note.—Additional meetings will be held at (1) Scunthorpe (jointly with the Lincolnshire Iron and Steel Institute) on Tuesday, October 6; (2) Sheffield (jointly with the Sheffield Metallurgical Association) on Tuesday, October 20; (3) Manchester (jointly with the Manchester Metallurgical Society) on Wednesday, October 21, and (4) Glasgow (jointly with the West of Scotland Iron and Steel Institute) on Friday, October 30, 1931.

A cooling compound for hot bearings can be made from one part of white lead, two parts of tallow and one-fifth part of graphite, thinned to flowing consistency with cylinder oil.

The Reactivity of Coke Coated with Lime and the Production of Low-Carbon Iron in the Cupola.

The reactivity value of a coke is the extent to which it is capable of reducing CO_2 to CO. For iron-melting in the cupola, a coke of a low reactivity value is desired, because such coke is not burnt to an appreciable degree until it reaches the melting zone. It is usually assumed that the coke can be rendered less reactive with CO_2 by coating it with lime. By laboratory experiments, E. Piwowarsky has shown that this is not the case.*

In these experiments, small coke pieces of 3 to 5 mm. (0.12 to 0.2 in.) dia. were heated in a porcelain tube in nitrogen to 900 and 1,000 deg. C. respectively. Then a current of carbon dioxide was passed over the coke at a velocity of 10 litres per hour, and the CO content of the final gas was determined every five minutes with the aid of the Orsat apparatus. As the effect of the moisture content of the CO_2 upon the reaction in question is not yet clearly understood, experiments with both dry and wet CO_2 were made, the latter containing 15.3 grams H_2O per m^3 (0.015 oz. per cub. ft.). The coke was tested in the "as-delivered" condition, and after being treated with lime water. To ensure a good penetration of the lime into the pores, the coke pieces were placed into an evacuated vessel, into which the lime water was run. In each experiment the CO content of the final gas decreased at first and then remained constant. These constant values, which can be regarded as characteristics of the temperature and coke used, are plotted in Fig. 1. In order to eliminate individual errors of measurement, each test was checked by another experimentator, which fact is indicated in Fig. 1 by different marks (dot, circle and cross). The experimental results show that in all the cases the coke coated with lime exhibited the higher reactivity value. A probable explanation of this strange fact is that the hydroxide of calcium may react with the carbon dioxide, forming carbonate of calcium. The reaction is accompanied by an increase in volume which may cause cracks and fissures in coke and thus increase the surface area exposed to the carbon dioxide.

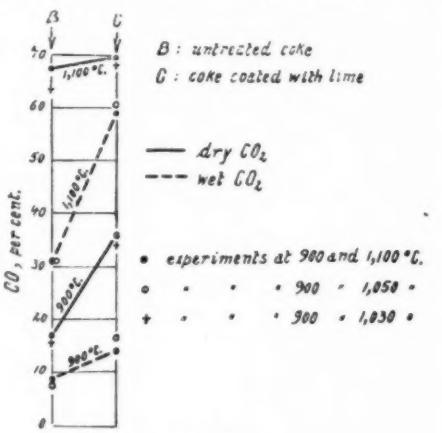


FIG. 1.

On account of the foregoing and other experiments, the author has come to the conclusion that the advantages chiefly claimed for the application of lime-coated coke (no premature combustion of the coke in the shaft of the cupola and reduction of the total-carbon content of the molten iron) do not really exist. The degree of carburisation is mainly influenced by the conditions prevailing in the hearth of the cupola, viz., the temperature of the hearth, the properties of the coke, and the time of contact between the molten iron and the bed coke. The last factor is dependent on the height of the hearth and tapping conditions, whether intermittent or continuous. The degree of carburisation is further decreased by using a hard large-sized coke and as low a percentage of charge coke as possible. An increase in the volume of blast may affect the degree of carburisation in that the molten iron reaches the hearth in a more oxidised condition, requiring a large quantity of carbon for reduction. In a medium-sized cupola, 180 to 220 m^3/m^2/min. of blast (635 to 775 cub. ft. of blast per sq. ft. of cross-sectional area per minute) can be delivered without any serious effect upon the working of the furnace, if the following measures be taken:—(1) Using more effective blowers; (2) evenly distributing the blast by many tuyeres of small diameter; (3) using two rows of tuyeres, if necessary; (4) using recessed tuyeres; (5) preheating the blast or enriching it with oxygen; (6) determining the suitable height of the coke charge by experiments. A high superheat of the molten iron can be obtained by (1) hastening the combustion of the coke, using as low a percentage of charge coke as possible and a blast volume over 565 cub. ft. per sq. ft. per min.; (2) increasing the emissive power of the flames (water injection, tar mist); (3) eliminating the cooling effect of the large blast volume (preheating or enriching the oxygen); (4) adjusting sizes and quantity of the coke and iron charge. With the aid of the measures outlined above it was possible to obtain a well superheated iron containing 1.6 to 1.8 per cent. of carbon, from a cupola of 300 mm. (11.8 in.) dia., with a mixture consisting of 100 per cent. of steel scrap containing 0.15 per cent. of carbon. After 3 to 5 per cent. of oxygen had been added to the blast, an iron containing 1.25 to 1.5 per cent. of carbon was obtained.

Criticising the experiments and considerations of Piwowarsky, F. W. Corsalli states that the behaviour of lime-coated, large-sized coke, such as is used in practical working, cannot be compared with that of small pieces of 3 to 5 mm. dia.* Moreover, the method of applying a coat is not confined to a simple treatment with lime water, but is modified according to the quality of the coke and the purpose aimed at. It is possible to protect the coke to such an extent that it will not be burnt at all.

* "Die Giesserei," 1930' No. 48.

Electrical Cleaning of Gas and Air.—In America the International Precipitation Company and the Research Corporation have made great strides in this branch. On the Continent of Europe the Lurgi Apparatebau Gesellschaft and Siemens-Schuckert Werke have gradually acquired the whole of the field, and Lodge-Cottrell, Limited, of Birmingham and London, have operated inside the British Empire, developing the process on the basis of the original ideas and patents of Sir Oliver Lodge. As a result of recent negotiations, an agreement has been entered into between all the above-mentioned firms whereby they have resolved to exchange all patents and experience, and to support each other in every way, with a view to bringing the process up to its fullest perfection.

Arc-Welded Steel House in Cleveland, U.S.A.—Construction was recently started on what is believed to be the first house of complete arc-welded steel construction built in America. The residence, a two-storey structure of French architecture, which will cost about $25,000, was being erected in the Shaker Heights district of Cleveland. There is about 10 tons of steel in the framework. Three-inch, light-weight standard Carnegie channels and 6-in., light-weight standard Carnegie beams are the principal shapes employed. With one welder and three structural iron workers, about four tons of steel were erected during the first day of construction. All steel was cut to size before delivery to the job. It was expected that the entire arc-welded steel framework could be completely erected in 2½ working days, fabrication and erection welding being done on the site. It is stated that these houses will cost approximately 40c. (20d.) a cub. ft., and that the use of welded steel construction will cost only $72 more than the traditional type of wood structure.—"Iron Age."

* "Die Giesserei," 1931, No. 5.

Internal Cooling Spirals.

The receipt of a leaflet from Messrs. John A. Smeeton, Limited, of 15, Victoria Street, London, S.W.1, describing a line of internal chilling coils and spirals, gave us a good deal of pleasure, because it removes from foundry practice one more improvisation from which the foundry industry has so long suffered. A number of the more ingenious foundrymen have for years inserted one or more iron sprigs or the like in the thicker sections of castings in order to prevent draws and spongy places by attempting to equalise the rate of cooling throughout the casting taken as a whole, by causing the mass of metal in the heavier sections to be cooled more quickly than would otherwise be the case. This improvisation is satisfactory only to a limited extent, because to ensure an important amount of cooling, a reasonable surface area had to be ensured. But with increasing area came increasing mass and a liability of its non fusion with the metal. Obviously then to ensure a maximum surface area and so a cooling effect associated with minimum mass, a spiral suggested itself as being ideal. There then only remained to be solved the question of attachment to the mould, and a wire construction lends itself admirably to formation of spikes at the terminals such as are shown in Fig. 1, at A, B and C. Two typical applications are shown in Figs. 2 and 3, representing, respectively, a cogged wheel and a globe valve.

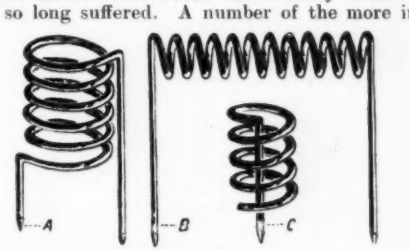


FIG. 1.—INTERNAL COOLING SPIRALS.

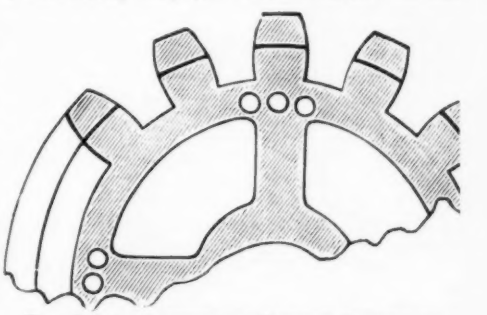


FIG. 2.—APPLICATION OF COOLING SPIRALS TO COGGED WHEELS.

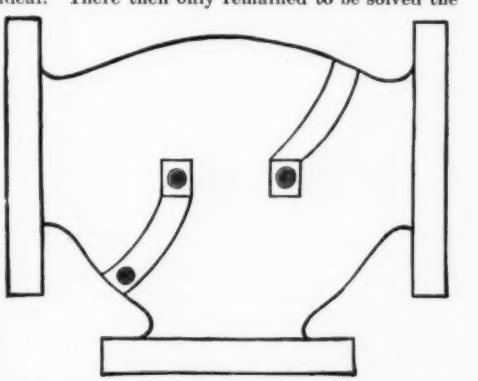


FIG. 3.—COOLING SPIRALS AS APPLIED TO A GLOBE VALVE.

There is available a particularly wide range of designs, made from mild steel wire and coated with tin.

Crane Equipment in Foundries.

By "Kilowatt."

One of the many problems encountered in the foundry is the provision of an economical and efficient method for the handling and conveyance of materials and castings from point to point. The rapid development in the application of electrically operated appliances during the past few years has caused manufacturers to devote special attention to the production of electric handling equipment, and there is little doubt that the installation of this class of equipment has done much towards reducing handling costs.

Electric-handling apparatus can be divided into two broad classes:—(1) Intermittent, such as cranes, hoists, lifts and elevators; and (2) continuous, such as band conveyors and conveyor elevators. It is with the first class that this article will deal.

Types of Cranes.

It is not intended to discuss in detail the various designs and constructional data of cranes, as this would involve the reader in a mass of technique which might well prove misleading in the long run. However, one or two examples must be enumerated.

Primarily, there is the fixed crane, which has a revolving motion with either a fixed or variable radius. Under this heading must be included hoists, pulley blocks, jib cranes and wall cranes. The simplest form of fixed crane is the wall jib type, having a lifting and slewing motion on a fixed radius. This crane, which operates on a top and bottom pivot, can only work within the area of its radius of action, and, whilst cheaper in first cost and capable of performing quite a useful amount of work, its application is obviously restricted. The luffing crane, which is the next step in jib cranes, is fitted with a luffing gear—in addition to the hoisting gear—which gives the jib a variable radius. A still further development is the level luffing crane, which has found particular favour for loading and unloading at railway sidings and in large yards, on account of its combined rapid hoisting and luffing motions with small consumption of power. This type of crane, of which there are several designs, is invariably mounted on a carriage or gantry suitable for travelling along the rails at the quayside or railway siding.

Electric Overhead Cranes.

One of the most useful types of cranes is the electric overhead travelling crane. Whilst there is a number of designs of this class to meet specific requirements, particularly with regard to foundries, the general design has gradually reached some measure of uniformity, at any rate among the leading crane firms; but it must be admitted that there are still some differences of opinion and practice upon such questions as the most suitable current and the most efficient braking arrangements. These questions are intimately related, and it rests with the man on the spot to decide whether the measure of "creeping" speeds and mechanical braking obtainable with alternating current will answer his requirements, or whether the fine "creeping" speeds given by direct current and some form of potentiometer braking is essential.

The constructional features of an overhead travelling crane consist, briefly, of a bridge mounted on an elevated track and provided with mechanism necessary to give lifting, traversing and travelling and tipping motions. By this arrangement practically the whole of the floor area is covered. The overhead travelling crane can be divided conveniently into two distinct parts: (1) The movable bridge or girder, of sufficient length or span to run upon the overhead rails, and (2) the mechanism or lifting appliance which is mounted on the bridge itself and so arranged that it may traverse across it in either direction and thus pick up loads at any part of the span. The movable bridge consists of cross girders secured to end carriages, each of which is mounted on a pair of wheels.

Generally speaking, all crane girders are now built up of steel sections made by the open-hearth acid or basic process, and usually conform to the British Standards Specifications laid down for structural steel-work for bridges and general building construction. Under this specification, plates and sections must show a tensile breaking strength of 28 to 32 tons per sq. in. The three principal types of girder in use are: (1) rolled steel joists, which are the simplest type of girder, and frequently used for spans up to 40 ft. for light loads and 30 ft. for loads up to 20 tons; (2) single web plate girders, and (3) lattice girders. Each class is used according to the span and load carried.

Electrical Equipment.

Electric power is taken to the crane through two cables running the full length of the gantry, supported on suitable insulators and fixed alongside the gantry rails, girders, or in any other convenient position. These cables convey the current to the point where the operator controls the various motions. Single motors are sometimes used for the hoisting, traversing and longitudinal-travelling motions, these motions being obtained through friction clutches and gears. It is the more general practice nowadays, however, to adopt the multi-motor system by providing a motor for each of the three motions.

Experience has proved that electrically-operated overhead travelling cranes are more efficient and economical in practice when the lifting, traversing and travelling motions are each actuated by a separate motor. Greater ease and rapidity in handling loads is assured, and there is less consumption of current than in the case of a single-motor type crane, which has to overcome the great amount of friction in the gearing necessary for transmission of power to several motions.

Installing Electric Overhead Travelling Cranes.

When the installation of an electrically-operated travelling crane is under consideration, it is desirable that the question of head room should be given careful attention. Obviously, the greater the head room required by the crane—that is to say, the distance from the tread of the gantry rails to the highest projection of the crab—the less available height there will be through which the load can be elevated. Special care is taken when designing the crab to reduce the head room of only 3 ft. 4 in. in 5-ton sizes.

Clearly, the question of selecting the most suitable type of motor for crane work must first be governed by the system of electrical supply available. If a choice of supply is available, then the direct-current system is to be favoured for its greater flexibility of control and higher operating efficiency; this, of course, does not mean that cranes cannot be operated on the alternating-current system.

Dealing with direct-current motors first, the choice lies between the series-wound, shunt-wound and compound-wound types, and of these three the series-wound machine is undoubtedly the most suitable, both on account of its high starting torque and its automatic speed variation.

As the starting torque of a crane is high, a motor is required that will exert a powerful torque at starting from rest, and this is really the outstanding characteristic of the series-wound motor. Instead of varying directly with the current, as in the case of the shunt-wound machine, the torque increases practically with the square of the current; that is to say, if the current is doubled, the torque is increased nearly four times. This particular characteristic of the series motor is due to the fact that when a series-wound machine is switched on, the whole of the current flows through both field coils and armature, the effect in the field being to bring the magnetic strength to practically its full amount; thus the torque—product of magnetic strength—will be a maximum for that particular current value.

Consumption of American Blast Furnaces.

According to the Annual Statistical Report of the American Iron and Steel Institute for 1930, in the manufacture of pig-iron (excluding ferro-alloys) there was a slight decrease last year in the proportion of iron ore used and a large increase in "cinder, scale, etc." the "etc." including scrap, largely borings and turnings. In 1927-8-9 the consumption of cinder, scale, scrap, etc., ran to about 0.179 ton per ton of pig-iron made, while in 1930 it rose to 0.203 ton. The supply of cinder and scale is closely related to the production of steel, which decreased 28 per cent. from 1929 to 1930, whereas the cinder, scale, scrap, etc., decreased only from 7,433,717 tons to 6,296,197 tons, or by 15 per cent. Evidently, then, there was a large increase in the amount of scrap used per ton of pig-iron made.

Borings and turnings are so cheap that they are, in many cases, cheaper than the integrated cost of iron ore delivered to the blast furnace. Curiously enough, this transition to the use of more scrap did not decrease the total consumption of ferrous material by the furnaces. Per ton of pig-iron made there was in 1929 1.750 tons of ore, briquettes, etc., and 0.178 ton of cinder, scale, scrap, etc.; total, 1.928 tons; in 1930, 1.730 tons plus 0.203 ton or 1.933 tons in all.

Coke consumption per ton of pig-iron made has been decreasing, with harder driving, improved practice, and perhaps better coke. There was a rise to 1918, when there was poor coke and much inefficiency, there being 2,375.2 lbs. of coke per ton of pig-iron, including ferro-alloys. Thereafter there were continuous decreases, except for a back-set in 1923 and again in 1924, consumption being down to 2,046.8 lbs. in 1930. For the last five years consumption per ton of pig-iron only (excluding ferro-alloys) has been given, this decreasing from 2,060.9 lbs. in 1926 to 2,015.8 lbs. in 1930.

Alluminium alloys can be etched for plating by dipping them for 20 sec. in a dip composed of three parts of concentrated nitric acid and one part of hydrofluoric acid.

Levant Fair.—An international samples exhibition is to be held at Bari (Italy) from September 6 to 21, 1931, to enable international producers desiring to open new markets in South Italy, Balkans, North Africa, Near and Far East, to display their products. The agent for the British Isles and Colonies is Dr. F. Pesenti, 98, Westminster Bridge Road, London, S.E.1.

A 32-in. Cold-Rolled and Hardened Steel Band.—A cold-rolled and hardened steel band 32 in. wide, 360 ft. long and 0.0472 in. thick, has been manufactured by the Sandvik Steel Works, Sweden. In the matter of width this achievement is said to represent a world's record in cold-rolling and hardening. These wide steel bands are primarily intended for steel belt conveyors, but are used also for other purposes. In the course of only a few years the width of steel bands has been increased from 18 in. to 24 in., and now to 32 in. In this connection, the Sandvik works has rolled steel strip measuring only 0.0001182 in. in thickness. The rolling and auxiliary machinery for finishing 32 in. steel bands includes a cold-rolling mill of a weight of about 200 tons. The bearings in the largest roll alone weigh about 11 tons.—"Iron Age."

"They're giving us excellent service"

"How's that test going with No. 8 Furnace, Blythe?"

"You mean the one we liked with those Gibbons' Refractories, Mr. Broadbent?" "Very well, indeed—they're giving us excellent service. We used to renew the side walls and roof every six months with the old sort of brick, but I reckon these'll last for at least a couple of years."

"H'm. That's an economy. Wish we'd tried them out before. It's going to pay us to use Gibbons' Refractories in future. Let's see—they've got a Consulting Service Department, haven't they?"

"That's so—very helpful I've found them, too."

"Well, ask someone to come along, and we'll get their advice on the best linings for *all* our furnaces."

If you, too, are interested in better and more economical furnace linings, ask for a representative to call, or send for illustrated Catalogue.

GIBBONS' REFRACTORIES

GIBBONS (DUDLEY) LIMITED, *Head Office:* **Dibdale Works, Dudley, Worcs.**

Phone: Dudley 3141. *Telegrams: "Machine, Lower-Gornal."*

***London Office:* 151, Palace Chambers, S.W.1.** *'Phone: Victoria 0128.*

(Adjacent Westminster Tube Station)

Streets

Trade Talk.

The Bengal Iron Company, Limited, has set up agencies for selling cast-iron pipes in Singapore, Bangkok and Soerabaya. The pipes are being sold at slightly lower prices than French and Japanese pipes.

An outbreak of fire occurring at the Clyde Iron Works, Tollcross, of Colvilles, Limited, was caused by the boiling-over of a tank containing 4 tons of tar. Damage was done to the staging and a number of moulds.

Siam's adoption of the Diesel-electric rail traction system has been announced by Mr. Phya Sarasastra, Commissioner-General of the Royal State Railways of Siam, at the Siamese Legation, London. The Siamese Government, he stated, has recently placed contracts on the Continent for thirteen Diesel locomotives, two of which have already been shipped.

New work will come to Messrs. Vickers-Armstrongs, Limited, as the result of the signing in Lisbon of a contract with the Portuguese Government for the armaments equipment of two warships. It is stated that the heavier work will be well distributed between the firm's factories at Sheffield, Barrow-in-Furness, and on the Tyne, and the light armaments and some of the other work will go to factories at Erith, Crayford and Dartford. The work will be spread over about two years.

The Department of Commercial Products of the City of London College announces a course of 25 lectures on iron and steel, to be given by Mr. T. Barton Kelly, on Thursdays, from 6 p.m. to 7 p.m., commencing on September 24. The fee for the course is 25s. 6d. A college examination in iron and steel will be held at the conclusion of the course, and short course certificates awarded to successful students. In the event of a sufficient number of students presenting themselves, a short course of lectures on special steels and non-ferrous metals might be arranged.

Ruston & Hornsby, Limited, of Lincoln, and R. A. Lister & Company, Limited, of Dursley, have established jointly a new company—the Ruston-Lister Marine Company, Limited—in a bid to secure a bigger share in the marine-engine business of the world. Two directors from each of the parent companies will be on the board of the new company, and its registered offices are to be at Imperial House, Kingsway, London, W.C.2. The combined assets of the two firms behind the company are, with their associated companies, over £6 million. The new company is a direct outcome of the agreement made by Ruston & Hornsby and R. A. Lister & Company, over a year ago, to develop together the overseas markets in which they had previously been competing.

Contributions to the Falkirk Infirmary have been made by employees of the following firms:—Broomside Foundry Company (1922), Limited, Bonnybridge, £12; Mitchell, Russell & Company, Limited, Bonnybridge, £49; Smith & Wellstood, Limited, Bonnybridge, £100; J. G. Stein & Company, Limited, Castlecary, £130; J. Dougall & Sons, Limited, Bonnybridge, £33; Lane & Girvan, Limited, Bonnybridge, £34. Donations have also been made by the following firms:—J. Dougall & Sons, Limited, £5; Mitchell, Russell & Company, Limited, £2 2s.; Smith & Wellstood, Limited, £10; and J. G. Stein & Company, Limited, £15. The Glengarnock employees of Colvilles, Limited, have contributed during the year the sum of £323 10s. to infirmaries and nursing associations.

The "British Exhibitor," which is to make a cruise to South America to seek new trade for British manufacturers, is now in the Thames. She is a twin-screw quadruple-expansion ship with a speed of 15 knots, and her light draught will make it possible for her to dock alongside the quay at practically all the ports she visits. Space is provided on board for nearly 500 separate exhibits. Many exhibitors intend to send out their own representatives in the ship. For firms who cannot be directly represented the company undertake, so far as possible, to act by establishing actual agencies for them or securing representatives, and they will also assist by providing agents on the spot in the countries visited, with detailed market reports on which trading policy may be based. The many British industries to be represented in the ship will include engineering, agricultural machinery, tractors, chemicals, hardware and cutlery. Lord Auckland, managing director of the British National Exhibition Ship, Limited, will be in charge of the expedition.

The following statement has been issued by the committee of control of the International Tin Pool:—An International Tin Pool has been formed with the concurrence of the four Governments which signed the International Tin Quota Agreement. The pool will work in close co-operation with the International Tin Committee. The tin to be acquired by the pool will be released in accordance with a sliding scale of prices accepted by the four Governments which signed the quota agreement. The initial release of 5 per cent. of the pool's holding of tin will become effective if and when the average price of spot tin on the London Metal Exchange shall, during any completed calendar month, have exceeded £150 per ton. In order to facilitate the formation of the pool the four Governments have given reciprocal guarantees whereby they undertake to continue unconditionally the quota agreement until the date fixed for its expiry, i.e., February 28, 1933, and further, if at that date the pool shall not have been liquidated, to extend the quota agreement up to a total period not exceeding three years from the date—i.e. August 12, 1931—of the formation of the pool.

New Government contracts listed in the "Ministry of Labour Gazette" for August include the following:—Admiralty:—Steelwork: Walker Bros., Limited, Walsall; Earl of Dudley's Round Oak Works, Limited, Brierley Hill. Steel rails, etc.: Dorman, Long & Company, Limited, Middlesbrough. Steel sheets: J. Beardshaw & Son, Limited, Sheffield. Wire rope and strand steel: Whitecross Company, Limited, Warrington; British Ropes, Limited, Dagenham. War Office:—Metal rod (copper alloy): Vickers-Armstrongs, Limited, Newcastle-upon-Tyne. Steel bars: W. Jessop & Sons, Limited, Sheffield. Mild steel: Dorman, Long & Company, Limited, Middlesbrough. Steel rails, fishplates, etc.: Wm. Jones, Limited, London. Crown Agents for the Colonies:—Galvanised sheets: Wolverhampton Corrugated Iron Company, Limited, Wirral. Laminated springs: Steel, Peech & Tozer, Limited, Sheffield. Pipes: Stanton Ironworks Company, Limited, Nottingham. Rails and fishplates: British (Guest Keen Baldwins) Iron & Steel Company, Limited, London. Steel plates: P. & W. MacLellan, Limited, Glasgow. Steel poles: British Mannesmann Tube Company, Limited, London. Steelwork: British Steel Piling Company, Limited, London; A. Findlay & Company, Limited, Motherwell; Horseley Bridge & Engineering Company, Limited, Birmingham; F. Morton & Company, Limited, Liverpool; Patent Shaft & Axletree Company, Limited, Wednesbury.

Personal.

Mr. Frank Hudson, chief metallurgist and chemist to the Fordath Engineering Company, Limited, Hamblet Works, West Bromwich, has resigned his position and is joining the staff of Messrs. Glenfield & Kennedy, Limited, of Kilmarnock. His appointment dates from October 1.

Wills.

Jones, Sidney J., managing director of G. R. Jones & Company, Limited, steel and file manufacturers, Sheffield ... £17,708

Foy, Frederick, chairman of the Reliance Manufacturing Company (Broughton), Limited, sheet-metal workers, of Manchester... ... ... £13,092

Obituary.

Mr. J. C. B. Firth, a director of Messrs. Thos. Firth & John Brown, Limited, Sheffield, died on Sunday, August 23, at the age of 38.

Mr. William S. Hall, a native of Bury and founder and president of the Eagle Iron Works, Minneapolis, died last month at the age of 87. He went to the United States in 1868.

Mr. James Adamson, hon. secretary of the Institute of Marine Engineers, died at his home at Harrow on August 20. He was 81 years of age, and had been hon. secretary of the Institute since its foundation in February, 1889.

Messrs. Ferguson Bros. (Port Glasgow), Limited, have received a contract for a dredger for London owners.

Contracts Open.

Ballygally, Ireland, September 10.—6,550 yds. of 4-in. and 870 lineal yds. of 3-in. cast-iron water pipe, with valves, etc., for the Larne Rural District Council. Mr. S. Robinson, Victoria Street, Larne.

Darlington, September 10.—Cast-iron pipes, from 2-in. to 6-in. dia., for the Durham County Water Board. Mr. W. Read Ward, 77, Northgate, Darlington.

Johannesburg, S.A., October 19.—2,000 wagon wheels and axles, complete, for the South African Railway and Harbours. The Department of Overseas Trade. (Reference G.X. 10,682.)

London, E.C., September 14.—Cast-iron and spun iron socket and spigot straight pipes, for the Metropolitan Water Board. The Chief Engineer, 173, Rosebery Avenue, E.C.

Ormskirk, September 11.—5-in., 6-in., 7-in., 10-in. and 12-in. water mains and valves, etc., for the Urban District Council. Mr. H. B. Ward, 26, North John Street, Liverpool. (Fee £2, returnable.)

Poole, September 15.—Triple-expansion pumping engine and boiler plant, etc., for the Town Council. The Waterworks Engineer. (Fee £5 5s., returnable.)

Pretoria, S.A., September 25.—Switchgear, for the Town Council of Pretoria. The Department of Overseas Trade. (Reference A.X. 11,075.)

Simla, September 17.—10 tons of horseshoe nails, for the Director of Contracts, Army Headquarters, Simla. The Director-General, India Store Department, Belvedere Road, London, S.E.1. (Fee 5s., non-returnable.)

Company Meetings.

W. H. Dorman & Company, Limited.—The annual meeting of Messrs. W. H. Dorman & Company, Limited, Stafford, was held in London on August 24. Mr. Walter Haddon (the chairman), who presided, said that orders on hand at the present time were considerably lower than they were at the same time last year. The new Diesel engine to which he made reference last year looked very promising. Since the accounts were closed they had received orders which had justified their expenditure in the past, and this promised to be a valuable addition to their range of industrial engines.

Bengal Iron Company, Limited.—The annual meeting of the Bengal Iron Company, Limited, was held in London last month. Mr. Wm. Turner MacLellan (chairman and managing director), who presided, regretted that the report was not a more cheering one. He thought that last year was the worst he had seen in the iron trade during his experience of it, and unfortunately the outlook for the current year, complicated as it was by political circumstances, was not a bright one. They were doing everything they could to economise, but the strictest economy would not counterbalance want of output. During the year their staff in India had had a trying time, but nothing had occurred in the way of unrest at their works.

Reports and Dividends.

Mansfield Engineering Company, Limited.—Loss for the year of £5,279.

J. Grayson, Lowood & Company, Limited.—Loss of £901, reducing the credit balance carried forward to £1,079.

R. & W. Hawthorn, Leslie & Company, Limited.—Dividend of 5 per cent., less tax, for the year to June 30 last.

W. H. Dorman & Company, Limited.—Gross profit, £33,214; net loss of £6,615, increasing the adverse balance to be carried forward to £47,244.

Scottish Iron & Steel Company, Limited.—Dividend on the preference shares for the half-year ending June 30, 1931, at the rate of 6 per cent. per annum.

J. Brockhouse & Company, Limited.—The directors recommend payment of a dividend of 2½ per cent., making a total distribution of 6 per cent. for the year.

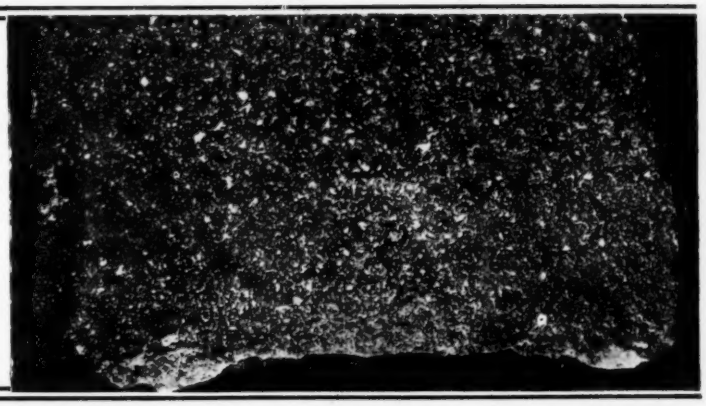
Brightside Foundry & Engineering Company, Limited.—Profit, £5,398; brought in, £13,843; preference dividends, £2,250; dividend of 4 per cent. on the ordinary shares, £3,100; carried forward, £13,892.

PIG IRON

MANUFACTURERS of Foundry, Basic and Hematite qualities.

Delivery from stock.

Booklet giving analyses, etc., will be sent on request.



DORMAN LONG & CO. LTD

INCORPORATING

BOLCKOW, VAUGHAN & CO. LTD

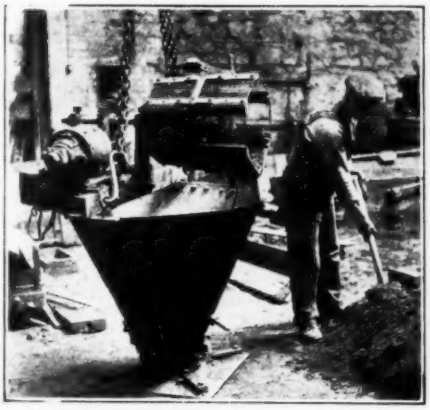
MIDDLESBROUGH

PORTABLE SAND HOPPER & RIDDLE

FOR NEW OR FLOOR SAND

CAPACITY 12 cwts. 3-3½ TONS RIDDLED per HOUR

ALSO MAKERS OF MACHINES FOR RUNNING UP LOAM CORES ON BARRELS. ANY DIAMETER. ANY LENGTH.



ASK FOR OUR UP-TO-DATE METHOD OF HEATING LADLES & SHANKS AND DRYING FLOOR MOULDS WITH GAS & AIR.

Manufacturers:

RITCHIE, HART & Co. Ld.

ENGINEERS, IRON & BRASS FOUNDERS.

MOUNTPOTTINGER FOUNDRY, BELFAST

DON'T SCRAP CASTINGS

USE

FERRUM CEMENTS

FERRUM CEMENT M6 is specially made for Foundry use. It sets very quickly, is metallic, and when set becomes part of the casting itself. It can be filed like iron.

FERRUM CEMENT No. 2 is slower setting, but extremely hard and metallic.

The QUALITY of FERRUM CEMENTS is proved by the ever increasing sales during the past 20 years.

Literature and free sample tins from the sole manufacturers:

THE AMALGAMS CO. LTD

186. Attercliffe Road, SHEFFIELD

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The industrial depression in the North of England is unrelieved, political developments having had little material effect. While welcoming the new spirit in which the country's difficulties are being tackled, industrialists fear that they will have to bear further burdens, in the way of heavier contributions for unemployment insurance, if not increased direct taxation. As stocks of unsold pig-iron remain large, consumers are content to purchase only as the occasion demands. However, the Cleveland makers, in spite of keen competition from other districts, firmly maintain their scale of minimum prices, which remain as follow :—No. 1 Cleveland foundry iron, 61s. per ton; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; and No. 4 forge, 57s. per ton.

Business in the East Coast hematite market remains poor, no transactions of any size being recorded. The home market is mostly in the hands of the makers, and prices vary considerably, according to size of order, date of delivery, etc. The nominal quotation for East Coast mixed numbers remains at 61s. per ton. On the North-West Coast, business is very restricted and the future is uncertain. Stocks are considerable, and prices are inclined to drop. The nominal quotation for Bessemer mixed numbers remains at 66s. per ton at works, but lower prices could no doubt be negotiated for large orders.

LANCASHIRE.—The foundries remain short of orders, and their work is still interrupted by holidays, which will, however, soon be ceasing. Hence pig-iron makers report another dull week. Several inquiries for large tonnages of iron have been reported, and it remains to see whether any orders will materialise. For delivery to users in the Manchester price zone, Staffordshire, Derbyshire and North-East Coast brands of No. 3 iron remain at 67s. per ton, with Northamptonshire foundry iron at 65s. 6d., Derbyshire forge at 62s., Scottish No. 3 at 87s. to 87s. 6d., and West Coast hematite iron at about 80s. 6d. per ton.

MIDLANDS.—Staffordshire founders were hoping that a revision of prices would result from the meeting of the Central Pig-iron Producers' Association last week, but no changes were made. There is no improvement in the general consumption, and stocks continue to accumulate. For delivery to Birmingham and Black Country stations, the furnaces continue to quote 62s. 6d. for Northants No. 3 and 66s. for Derbyshire. North Staffordshire and Lincolnshire No. 3.

SCOTLAND.—Business is still very limited. In an endeavour to stimulate business, makers have reduced the price of No. 3 foundry, f.o.t. furnaces, to 69s. 6d. per ton, and of No. 1 to 72s. per ton. Continental No. 3 is obtainable at 52s. 6d. to 53s., f.o.t. Grangemouth, with Middlesbrough No. 3 at 58s. at Grangemouth.

Finished Iron.

The mills are finding business very difficult to obtain, and, owing to the strong competition for the little business passing, prices vary considerably. Staffordshire crown iron ranges from £9 5s. to £10, with nut and bolt iron at from £8 5s. to £8 10s., the bulk of the latter grade of iron, however, still being bought from the Continent at much lower figures. The price of Staffordshire marked bars is maintained at £12 per ton at works.

Steel.

There has been no improvement in the general consumption of finished steel. It is hoped that the recently concluded agreement between the steel and shipbuilding industries, to co-operate in the obtaining of foreign orders, will shortly have some beneficial effect. Meanwhile, however, the market remains poor. The demand for semis is limited, and the foreign mills are capturing the bulk of the business, at prices with which the home producers cannot hope to compete.

Scrap.

Slightly more business is passing in the Cleveland market, but prices have not improved. The foundries have again started work after the holidays, and deliveries of scrap iron have been resumed. Ordinary quality is steadily quoted at 40s., and good machinery quality at 42s. per ton. The Midlands market remains weak. Little new business is being transacted, and the furnaces are only taking limited supplies. Heavy machinery metal shows a tendency towards weakness at 45s. to 47s. 6d. delivered, light metal being quoted at 37s. 6d. per ton, delivered. There are no developments in the South Wales market, business remaining very poor. The scrap market in Scotland is still in a weak position. There is no improvement in the demand, and, at the present prices, merchants are not very eager to sell. Machinery cast-iron scrap, in pieces not exceeding 1 cwt., suitable for foundries, continues to find sales at 47s. 6d. Ordinary cast iron to the same specification remains at 41s. 3d. per ton.

Metals.

Copper.—There has been a slightly stronger sentiment in copper during the past week, due partly to a rumour that there is to be a conference between North American producers to secure a further restriction of output. The steadier tone shown by electrolytic copper is due to the fact that the large producers have not been pressing sales, and have left the bulk of the business to the Customs smelters. However, in the course of time, the large producers must be inevitably forced on the market, and then, it would seem, a fall in values can only be prevented by a revival in industry.

Closing quotations :—

Cash.—Thursday, £32 13s. 9d. to £32 15s.; Friday, £32 13s. 9d. to £32 15s.; Monday, £33 to £33 2s. 6d.; Tuesday, £32 17s. 6d. to £33; Wednesday, £32 16s. 3d. to £32 17s. 6d.

Three Months.—Thursday, £33 11s. 3d. to £33 12s. 6d.; Friday, £33 11s. 3d. to £33 12s. 6d.; Monday, £33 17s. 6d. to £33 18s. 9d.; Tuesday, £33 16s. 3d. to £33 17s. 6d.; Wednesday, £33 12s. 6d. to £33 13s. 9d.

Tin.—The recent completion of the long-needed pool has seen much stronger support for tin shares. The scheme for forcing up the price appears to be complete. However, this artificial controlling of the market will be of no value unless there is a considerable improvement in the actual consumption, and there are no signs as yet of any developments in this direction. Tin lost ground on Tuesday as a result of the publication of the August statistics, which were regarded as unsatisfactory. A decrease of from 2,000 to 3,000 tons in the visible supply and the unshipped Straits surplus was expected, but the reduction was only 1,314 tons. It seems that the international scheme for control of production is not being strictly carried out.

Official closing prices :—

Cash.—Thursday, £121 to £121 2s. 6d.; Friday, £120 to £120 2s. 6d.; Monday, £121 to £121 2s. 6d.; Tuesday, £120 to £120 2s. 6d.; Wednesday, £118 5s. to £118 7s. 6d.

Three Months.—Thursday, £123 10s. to £123 12s. 6d.; Friday, £122 10s. to £122 12s. 6d.; Monday, £123 12s. 6d. to £123 15s.; Tuesday £122 10s. to £122 12s. 6d.; Wednesday, £120 15s. to £120 17s. 6d.

Spelter.—During the period January to July of this year, the average monthly imports of spelter into the United Kingdom were 13,887 tons, or about 1,200 tons more than during the corresponding period of last year. These figures, in view of the limited consumption, were certainly very disquieting. However, it is hoped that the strong steps taken by the new cartel to restrict supplies will bring about a more satisfactory proportion between production and consumption. Stocks in official warehouses, however, at the end of August were 22,185 tons, against 21,607 tons a month earlier.

Daily fluctuations :—

Ordinary.—Thursday, £12 1s. 3d.; Friday, £11 16s. 3d.; Monday, £11 11s. 3d.; Tuesday, £11 10s.; Wednesday, £11 8s. 9d.

Lead.—In spite of the 20 per cent. cut in production already in force, there has been only a very slight reduction in warehouse stocks, the amount at the end of August being 13,869 tons, against 14,354 tons a month before. It remains to be seen whether matters will be remedied by a revival in consumption during the autumn. Indeed, everything depends upon this one factor.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £12 5s. Friday, £12 2s. 6d.; Monday, £12; Tuesday, £11 6s. 3d.; Wednesday, £11 1s. 3d.

Students' Corner.

(*Continued from page* 140.)

Q.—What are the steps to be taken for the burning-on of a roll neck?

A.—The preparation of and process used for every weld must be considered separately and notes taken of the design, thickness, etc. With circular castings of the hollow type, or bed-plates with walls of metal tied with brackets and flanges, pre-heating, whether done by fires, flame, stoves or molten metal, must be done slowly, as must also be the cooling. Roll-neck breakages are frequent in rolling mills; hence a foundry in close proximity can make good the breakage, so far as the neck is concerned, in a day. It must be understood that the result of the burn is a new neck, the broken one being discarded. First a hole is dug in the foundry floor for the reception of the roll, the fracture being on a level with the foundry floor; sand is then filled around the roll. The mould forming the new neck, previously made in a metal box part with strong sand and dried, is rather larger in diameter than the old neck to allow for machining. On a level of the broken part of the neck provision is made for 3 or 4 run-offs.

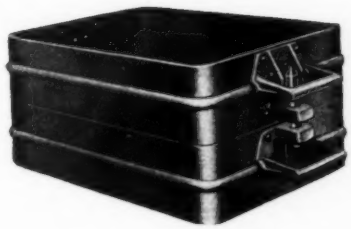
Before placing the neck box containing the mould in position for the burning operation, the roll at the fractured part is pre-heated to redness by means of molten metal poured around and on the broken part.

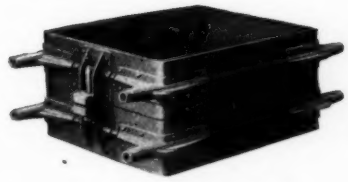
This pre-heating molten metal is divided into sections by means of flat cores or loam cakes, in order to make its removal easy and quick when the roll is sufficiently heated. When the pre-heating metal is removed, some cold sand is placed around, and the neck box is then placed in position and weighted, provision being made to receive the metal from the run-offs of that utilised during the burn. Pouring is now commenced; the impingement of the stream of metal from the ladle lip is directed on to the broken fracture, and each of the run-offs now being open, the metal passes through.

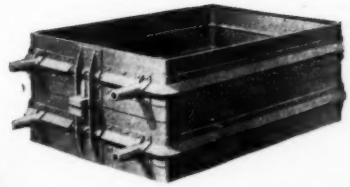
In a very short time the impingement of the stream liquefies the metal underneath. The ladle containing the metal, which was low down to commence with, is raised higher, as the burn proceeds, to increase the impingement. A feeling rod is used to ascertain the depth of the liquid metal in the roll, and if the rod, which has been previously marked, indicates that the metal beneath the old fracture is all in a liquefied state, then one by one the run-offs are closed up, the neck left full and well flushed with the remaining metal from the ladle. Some liquid shrinkage takes place, but the ladle still standing by makes that good. The roll is now allowed to cool off. The time occupied for the actual weld would be approximately 5 to 10 min.

The metal required for the burn depends upon the diameter of the roll. For safety, a roll neck 10 to 12 in. dia. would require 30 cwt. of metal. The pre-heating metal would be about 10 cwt. The cost of the molten metal and the labour spent on the job would be insignificant compared with the value of the roll.

(*To be continued.*)







Sterling

UP-TO-DATE MOULDING BOX EQUIPMENT.

STERLING
ROLLED STEEL
MOULDING BOXES

have been designed for THE MODERN FOUNDRY.

They are light and easy to handle.
Cannot crack or break.
Cannot spring.
Strong, Rigid, Durable and Permanently accurate.

BY ADOPTING STERLING BOXES IN YOUR FOUNDRY,

You will halve your moulding costs. You will increase production per man per hour, and reduce your box maintenance costs. You will turn out more accurate castings and thereby reduce your scrap and reject accounts. You will considerably reduce your fettling costs and put money into your pocket that is now running to waste.

STERLING BOXES save their cost in a few months and are obviously a sound investment for any foundry.

STERLING FOUNDRY SPECIALTIES Ltd.
Agents at:—London, Manchester and Glasgow.
BEDFORD.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	32	16	3
Three months	33	12	6
Electrolytic	35	15	0
Tough	33	0	0
Best selected	33	10	0
Sheets	64	0	0
India	44	15	0
Wire bars	37	2	6
Do., October	37	2	6
Do., November	37	2	6
Ingot bars	37	2	6
H.C. wire rods	38	10	0
Off. av. cash, August	32	12	3
Do., 3 mths., August	33	10	0
Do., Sttlmnt., August	32	12	1½
Do., Electro, August	35	19	7½
Do., B.S., August	34	1	3
Do., wire bars, August	36	11	6
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			6½d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	7¾d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7¾d.
Wire	7 d.
Rolled metal	6¾d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN.

	£	s.	d.
Standard cash	118	5	0
Three months	120	15	0
English	120	0	0
Bars	121	10	0
Straits	119	17	6
Australian	119	10	0
Eastern	125	2	6
Banca	123	5	0
Off. av. cash, August	114	19	1½
Do., 3 mths., August	117	9	4½
Do., Sttlmt., August	114	19	0

SPELTER.

	£	s.	d.
Ordinary	11	8	9
Remelted	10	12	6
Hard	8	10	0
Electro 99.9	13	12	6
English	12	2	6
India	10	10	0
Zinc dust	19	0	0
Zinc ashes	2	15	0
Off. aver., August	11	14	7¼
Aver. spot, August	11	8	9¾

LEAD.

	£	s.	d.
Soft foreign ppt.	11	1	3
English	12	10	0
Off. average, August	11	19	4½
Average spot, August	11	18	10½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	20	0	0
Do., V.M. ex-whf.	19	5	0
Rods	22	0	0
Boiler plates	14	12	6
Battery plates	16	5	0

ANTIMONY.

	£	s.	d.
Special brand, Eng.	34	0	0
Chinese	22	0	0
Crude	20	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	16	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 7 6
45/50%	£10 7 6
75%	£15 2 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9½d. lb.
Ferro-phosphorus, 20/25%	£15 10 0
Ferro-tungsten—	
80/85%	1/8½ lb.
Tungsten metal powder—	
98/99%	1/11½ lb.
Ferro-chrome—	
2/4% car.	£28 0 0
4/6% car.	£21 5 0
6/8% car.	£20 12 6
8/10% car.	£19 17 6
Ferro-chrome—	
Max. 2% car.	£29 17 6
Max. 1% car.	£33 15 0
Max. 0.70% car.	£35 12 6
70% carbon-free	9¾d. lb.
Nickel—99% £170 0 0 to £175 0 0	
Ferro-cobalt	8/- lb.
Aluminium 98/99%	£85 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export (nom.)	£ 9 0 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales						
Heavy steel	1	17	6 to	1	19	0
Bundled steel and shrngs.	1	14	0 to	1	18	0
Mixed iron and steel	1	13	0 to	1	15	0
Heavy cast iron				2	2	6
Good machinery for foundries				2	5	0
Cleveland—						
Heavy steel				1	17	6
Steel turnings				1	5	0
Cast-iron borings				1	2	0
Heavy forge				2	7	6
W.I. piling scrap				2	2	6
Cast-iron scrap	2	0	0 to	2	2	0
Midlands—						
Light cast-iron scrap				1	17	6
Heavy wrought				2	5	0
Steel turnings, f.o.r.				0	15	0
Scotland—						
Heavy steel				1	17	6
Ordinary cast iron				2	1	3
Engineers' turnings				1	5	0
Cast-iron borings				1	10	0
Wrought-iron piling				2	5	0
Heavy machinery				2	7	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	25	0	0
Brass	18	0	0
Lead (less usual draft)	10	0	0
Tea lead	7	0	0
Zinc	5	0	0
New aluminium cuttings	52	0	0
Braziery copper	22	0	0
Gunmetal	23	0	0
Hollow pewter	80	0	0
Shaped black pewter	58	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	61/6
Hematite M/Nos.	61/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
„ d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands—	
Staffs common*	—
„ No. 4 forge*	61/-
„ No. 3 fdry.*	66/-
Shrops basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	57/6
„ fdry. No. 3*	62/6
„ fdry. No. 1*	65/6
Derbyshire forge*	61/-
„ fdry. No. 3*	66/-
„ fdry. No. 1*	69/-
„ basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	72/-
„ No. 3	69/6
Hem. M/Nos. d/d	68/6
Sheffield (d/d district)—	
Derby forge	58/6
„ fdry. No. 3	63/6
Lincs forge	—
„ fdry. No. 3	63/6
E.C. hematite	75/6
W.C. hematite	81/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
„ fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	87/- to 87/6
Clyde, No. 3	87/- to 87/6
Monkland, No. 3	87/- to 87/6
Summerlee, No. 3	87/- to 87/6
Eglinton, No. 3	87/- to 87/6
Gartsherrie, No. 3	87/- to 87/6
Shotts, No. 3	87/- to 87/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.)	9	15	0 to	10	5	0
Nut and bolt iron	8	5	0 to	8	10	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				12	5	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	17	6 to	9	15	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)			6 12 6 & up.			
Flats—8 in. wide and over				8	12	6
„ under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)				9	5	0
Black sheets, 24g.	7	15	0 to	8	5	0
Galv.cor.shts.24g.	9	0	0 to	9	5	0
Galv. flat sheets	9	10	0 to	9	15	0
Galv. fencing wire, 8g. plain				12	0	0
Billets, soft	4	17	6 to	5	5	0
Billets, hard				6	12	6
Sheet bars	4	12	6 to	4	17	6
Tin bars				4	12	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	11½d.
Rods	11½d.
Tubes	1/6d.
Castings	11½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
3/- to 10 g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	16.76
No. 2 foundry, Valley	17.00
No. 2 foundry, Birm.	12.00
Basic	17.26
Bessemer	18.76
Malleable	18.76
Grey forge	18.26
Ferro-mang. 80%	85.00
O.-h. rails, h'y, at mill	43.00
Billets	29.00
Sheet bars	29.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.60
Tank plates	1.65
Beams, etc.	1.65
Skelp, grooved steel	1.60
Skelp, sheared steel	1.65
Steel hoops	1.80
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	2.90
Wire nails	1.90
Plain wire	2.20
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	22/6 to 25/-
„ furnace	14/- to 15/-
Durham and Northumberland—	
„ foundry	13/- to 14/-
„ furnace	13/-
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	13/- to 13/3
„	28×20 „	26/-
„	20×10 „	19/1½
„	18½×14 „	14/-
C.W.	20×14 „	12/6
„	28×20 „	25/-
„	20×10 „	18/10½
„	18½×14 „	14/-
Terneplates	28×20	25/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0 to	£7	0	0
Bars, hammered, basis	£16	10	0 to	£17	0	0
Bars and nail-rods, rolled, basis	£15	17	6 to	£16	5	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£32	0	0 to	£33	0	0
Faggot steel	£18	0	0 to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0 to	£12	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Current Discounts.

	Tubes.	*Fittings.*
Gas	62½%	57½%
Water ..	58½%	52½%
Steam ..	55%	47½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

			£	s.	d.	
Aug.	27	..	32	13	9	inc. 5/-
,,	28	..	32	13	9	No change
,,	31	..	33	0	0	inc. 6/3
Sept.	1	..	32	17	6	dec. 2/6
,,	2	..	32	16	3	,, 1/3

Electrolytic Copper.

			£	s.	d.	
Aug.	27	..	35	10	0	No change
,,	28	..	35	10	0	,, ,,
,,	31	..	36	5	0	inc. 15/-
Sept.	1	..	36	0	0	dec. 5/-
	2	..	35	15	0	5/-

Standard Tin (cash).

			£	s.	d.	
Aug.	27	..	121	0	0	inc. 30/-
,,	28	..	120	0	0	dec. 20/-
,,	31	..	121	0	0	inc. 20/-
Sept.	1	..	120	0	0	dec. 20/-
,,	2	..	118	5	0	,, 35/-

Tin (English ingots).

			£	s.	d.	
Aug.	27	..	122	0	0	inc. 30/-
,,	28	..	121	0	0	dec. 20/-
,,	31	..	122	0	0	inc. 20/-
Sept.	1	..	121	10	0	dec. 10/-
,,	2	..	120	0	0	,, 30/-

Zinc Sheets (English).

			£	s.	d.	
Aug.	27	..	20	0	0	No change
,,	28	..	20	0	0	,, ,,
,,	31	..	20	0	0	,, ,,
Sept.	1	..	20	0	0	,, ,,
,,	2	..	20	0	0	,, ,,

Spelter (ordinary).

			£	s.	d.	
Aug.	27	..	12	1	3	inc. 6/3
,,	28	..	11	16	3	dec. 5/-
,,	31	..	11	11	3	,, 5/-
Sept.	1	..	11	10	0	,, 1/3
,,	2	..	11	8	9	,, 1/3

Lead (English).

			£	s.	d.	
Aug.	27	..	13	10	0	No change
,,	28	..	13	10	0	,, ,,
,,	31	..	13	5	0	dec. 5/-
Sept.	1	..	13	0	0	,, 5/-
,,	2	..	12	10	0	,, 10/-

AVERAGE MONTHLY PRICES OF FURNACE COKE D/D MIDDLESBROUGH.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1901	0 17 6	0 14 0	0 13 0	0 14 0	0 14 6	0 15 0	0 15 3	0 15 3	0 15 9	0 16 6	0 16 9	0 16 9	0 16 4½
1902	0 16 9	0 15 0	0 15 0	0 15 0	0 15 0	0 15 3	0 15 3	0 15 3	0 15 6	0 16 6	0 16 6	0 16 6	0 15 5
1903	0 15 9	0 16 0	0 16 3	0 16 9	0 16 6	0 16 3	0 16 0	0 15 9	0 15 6	0 15 0	0 14 6	0 14 0	0 15 8½
1904	0 13 9	0 13 9	0 13 3	0 14 3	0 14 6	0 14 3	0 14 3	0 14 3	0 14 3	0 14 0	0 14 0	0 14 6	0 14 1½
1905	0 14 9	0 15 3	0 15 3	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 9	0 17 0	0 15 5½
1906	0 17 6	0 17 6	0 17 0	0 17 0	0 17 0	0 16 6	0 17 0	0 17 0	0 18 3	0 18 6	0 19 0	1 0 0	0 17 8½
1907	1 4 6	1 5 0	1 5 0	1 0 6	1 2 0	1 1 0	1 1 0	1 1 0	1 2 0	1 1 6	1 0 0	0 17 0	1 1 9½
1908	0 16 0	0 16 0	0 15 6	0 16 0	0 16 3	0 16 0	0 15 6	0 15 6	0 15 6	0 15 3	0 16 0	0 16 0	0 15 9½
1909	0 16 0	0 15 3	0 15 0	0 14 9	0 15 6	0 15 9	0 15 6	0 15 6	0 16 6	0 17 0	0 17 6	0 17 0	0 15 11½
1910	0 18 4½	0 18 6½	0 18 0	0 18 0	0 17 10½	0 17 0	0 16 1½	0 15 9½	0 15 11	0 16 0	0 15 9½	0 15 8	0 16 11
1911	0 16 0	0 15 10½	0 15 6	0 15 3	0 14 9	0 14 6	0 14 6	0 14 6	0 14 6	0 14 11½	0 15 0½	0 16 3½	0 15 1½
1912	0 17 3	0 17 3	0 18 6	0 18 10	0 19 0	0 19 4½	0 19 10½	1 0 9½	1 2 9	1 4 1½	1 5 8½	1 8 6	1 1 0
1913	1 5 9	1 4 11	1 5 0	1 5 0	1 4 9½	1 0 4½	0 19 5½	0 18 3	0 18 0	0 18 2½	0 18 6	0 18 6	1 1 4½
1914	0 15 2	0 17 1	0 17 0	0 17 0	0 17 4	0 17 6	0 17 6	0 18 5	0 18 4	0 17 9	0 17 6	0 18 5	0 17 8
1915	0 17 10½	0 17 9	1 0 4½	1 7 7½	1 9 4½	1 10 7½	1 9 7	1 7 3	1 5 4	1 4 9	1 9 6	1 13 0	1 6 1
1916	1 10 9	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6½
1917	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 14 3	1 15 6	1 11 2½
1918	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6
1919	1 15 6	1 15 6	1 15 6	1 15 6	2 1 6	2 1 6	2 3 9	2 10 6	2 10 6	2 10 6	2 10 6	2 10 6	2 3 5
1920	2 12 3	2 14 0	2 19 0	2 19 0	3 3 8	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 2 6
1921	3 1 0½	2 19 0	2 16 0	2 7 0	2 6 6	2 6 6	2 0 6	2 0 0	1 13 11	1 12 9	1 10 4½	1 8 3	2 3 6½
1922	1 7 0½	1 8 1½	1 9 7½	1 8 4½	1 7 11½	1 7 3	1 6 9½	1 6 10½	1 7 0½	1 10 2½	1 10 0	1 9 11½	1 8 3½
1923	1 11 3	1 14 6	2 0 1½	2 2 8½	2 4 4½	2 2 10½	2 1 0½	2 1 6	2 0 9½	1 18 9	1 18 8½	1 18 3	1 19 7½
1924	1 16 6½	1 14 9	1 11 11½	1 10 0½	1 8 1½	1 7 8½	1 7 3	1 6 3	1 6 0	1 5 0	1 5 0	1 5 0	1 9 5½
1925	1 4 10½	1 4 1½	1 13 3	1 2 4½	1 2 2½	1 1 5½	1 1 3½	1 4 9	0 18 10½	0 18 4½	0 19 6½	1 1 4½	1 2 8½ (5 months)
1926	1 2 1½	1 0 9	0 19 2½	0 18 6½	Strike	Strike	Strike	Strike	Strike	Strike	Strike	1 5 0	1 1 1½
1927	1 5 6	1 4 9½	1 6 1½	1 3 9	1 2 6	1 0 8½	0 19 4½	0 19 0	0 18 7½	0 18 0	0 17 10½	0 17 6	1 1 1½
1928	0 17 6	0 17 10½	0 18 0½	0 17 11½	0 17 8½	0 17 6½	0 17 7½	0 17 6½	0 17 6	0 17 7½	0 17 7½	0 17 6	0 17 8
1929	0 17 7½	0 18 0	0 19 0	0 19 6½	0 18 10½	0 19 10½	1 1 3½	1 1 8½	1 3 0	1 3 6	1 3 8	1 3 1½	1 0 9½
1930	1 2 6½	1 1 3	1 0 3	0 19 1½	0 17 7	0 16 10½	0 16 6	0 16 6	0 16 9	0 17 0	0 17 0	0 17 0	0 18 2½
1931	0 17 0	0 16 7½	0 16 0	0 16 0	0 15 11	0 15 5	0 15 1	0 15 0	—	—	—	—	—

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AGENTS, on commission basis, for the South, Midlands and Scotland, with good foundry connections, wanted for the sale of a high-grade Core Oil for green standing cores, and a Desulphurising Powder.—Please address offers, with references, to F. L. DE BRUIN, Neuss o/Rhine, Germany.

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4 ft. 6 in. "Evans" Sandmill ...	£20
6 ft. "Jackman" Sandmill ...	£38
Jackman Rotary Sifter	£8
"Macdonald" Pneumatic Sifter	£11

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